Technical Annex to Reply Comments of Northpoint Technology

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Overview

The purpose of this annex is to demonstrate how Northpoint can operate while protecting DBS systems. Northpoint can provide service to its customers and remain below the interference levels of DBS systems because of the technical and operational characteristics of both systems. Using C/I values proposed by the DBS industry to derive required maximum received signal strength (referenced to an isotropic antenna) or RSSi values, this Technical Annex identifies the potential for sharing between Northpoint's technology and DBS providers and shows interference to be minimal and – through the use of simple engineering techniques – eliminated altogether.

C/I ratio. Interference to DBS could arise when a Northpoint signal is above a certain C/I ratio. Two respondents (Tempo, Echostar) proposed that the C/I ratio should be 19-20 dB or above. Northpoint believes that a lower C/I value would not cause interference to DBS, see the discussion in Section 4 below. This annex will show how Northpoint will meet or exceed the 20 dB C/I interference ratios suggested by the DBS providers.

RSSi values. For purposes of this analysis, Northpoint has used data provided by the DBS industry where possible, with the conservative values used in favor of protecting the DBS systems. Given this, the RSSi of the Northpoint signals must be below -127.9 dBWi, depending on the azimuth of the DBS system to the Northpoint system (as prescribed in the Northpoint Technology).

Fundamental Sharing Point. The fundamental sharing point that allows Northpoint and DBS operations to coexist is the margin between the minimum required Northpoint RSSi and the maximum allowed interference levels to DBS. The Northpoint required RSSi at the edge of coverage is approximately -160 dBWi, including about 5 dB of margin for rain, atmospherics, fading and pointing losses. This level is lower than a level that will interfere with DBS systems. Maintaining the RSSi between the two boundary conditions is feasible, as this annex will show. Thus, with this fundamental sharing point, Northpoint can serve its customers while protecting DBS operations.

This sharing will be accomplished in three ways. First, merely taking account of the off-axis discrimination of DBS receive antennas reduces the potential universe of affected DBS subscribers to less than 1 percent. This is addressed in Section 1, below. Second, Northpoint plans to employ vertical plane attenuation, beam tilting and increased tower height, the combination of which will reduce the universe of affected DBS subscribers to zero for most typical Northpoint installations. This is addressed in Section 2, below. Finally, even if a few subscribers in fact receive inadequate protection (where the topology of the site differs substantially from a typical site), Northpoint licensees will upgrade or relocate DBS customer antennas to eliminate any concern. This is addressed in Section 3, below.

Section 1. Preliminary interference analysis.

Introduction. This section examines the baseline potential for interference for the Northpoint system. The section first address interference with DBS systems *before* considering the gain of DBS receive antennas in the horizontal plane. However, a key feature of the Northpoint Technology takes account of the off-azimuth discrimination of DBS antennas. The preliminary interference budget assumes a typical planned Northpoint transmitter with a 16 km diameter service area. A number of conservative assumptions were used to develop this initial interference budget, which is presented in the annex.[1]

Use of unrealistic assumptions about DBS antenna gains. Some of the DBS providers have suggested, as a preliminary matter, examining interference into DBS receivers with a 0 dBi gain. As shown below, such receivers only have 0 dBi gain in a relatively narrow portion of the horizontal pattern. This is almost always *not* the direction from which the Northpoint transmissions will originate. Nevertheless, for clarity, this analysis begins with that assumption.

Using the 0 dBi gain figure, DBS receivers within the Northpoint service area are protected by a C/I of 20 dB or greater outside a 2.5 km distance from the terrestrial transmitter. Because the ratio of affected area to the service area varies as the square of the distance ratios, only a small portion [$(2.5 \text{ km}/16 \text{ km})^2$ = 2.4%] of the service area would potentially be below a C/I ratio of 20 dB. This analysis is depicted graphically in Figure 1-1, showing that, without considering DBS off-axis rejection, Northpoint transmissions would not interfere with any DBS receivers more than 2.5 km from the transmitter.

[1] See the appendices for a discussion on the various engineering assumptions of this interference budget.

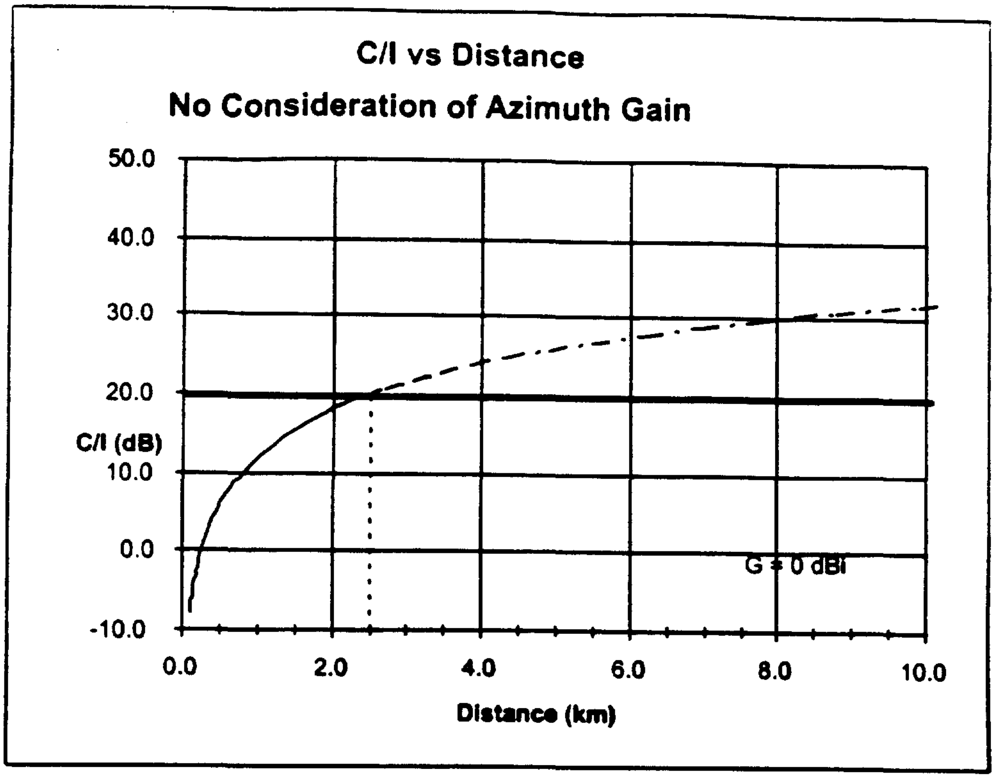

Figure 1-1

In fact, as noted above, this analysis ignores the gain of the typical DBS system towards the horizon. Taking additional discrimination of the DBS antenna into account, the next sub-section shows that less than 1.0% of the DBS service areas would be within a mitigation zone.

Consideration of Horizontal Gain Pattern of DBS antennas. The typical DBS gain in a horizontal direction[2] varies between -16 and 0 dBi. A DBS industry reference provides an excellent antenna pattern derived by the DBS industry from actual testing.[3] This

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[2] It is important to note that the DBS antenna pattern depicted accounts for the feed horn spill over several respondents cited in their objections.

[3] "This horizon gain characteristic is substantially unchanged for beam peak orientations between elevation angles of 20° to 50°." Terrestrial Interference in the DBS Downlink Band, An Analysis Submitted to the FCC April 11, 1994, page 11, Pattern page 10. DBS installations for elevation angles outside of these values would require further study, but are not expected to be significantly different from the results presented herein. Additionally, this analysis shows an antenna pattern towards the horizon of a typical 18" (45 cm) dish shows antenna discrimination of between 35 and 50 dB relative to peak gain of 34 dBi, for a horizontal gain of between -16 and -1 dBi, see the figure in the text. These figures are valid for elevation angles to the DBS satellites of between

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antenna pattern was modeled and the representation of the antenna pattern is seen in Figure 1-2.

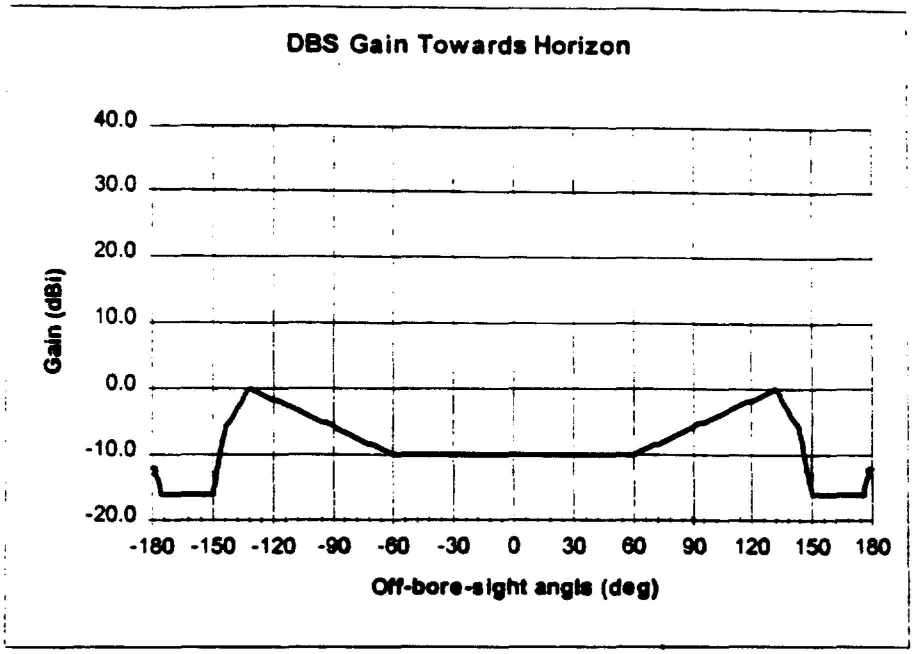

Figure 1-2 - DBS Horizontal Antenna Pattern.

As can be seen, the center of the pattern, (in the horizontal plane) there is substantially less gain than 0 dBi. Considering the gain as a function of azimuth, and using the data from Figure 1-2 above, there will be substantial off-azimuth rejection of Northpoint transmissions:

- about 14% of the DBS azimuth is below -15 dBi;
- an additional 42% is below -9 dBi;
- another 28% is below -3 dBi;
- and the remaining 16% is below 0 dBi.

As a result of the off-axis discrimination of DBS receive antennas, the potential interference distance at the proposed C/I levels is substantially decreased, as seen in Figure 1-3.

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20 and 50 degrees, which are typical values for DBS subscribers in CONUS.

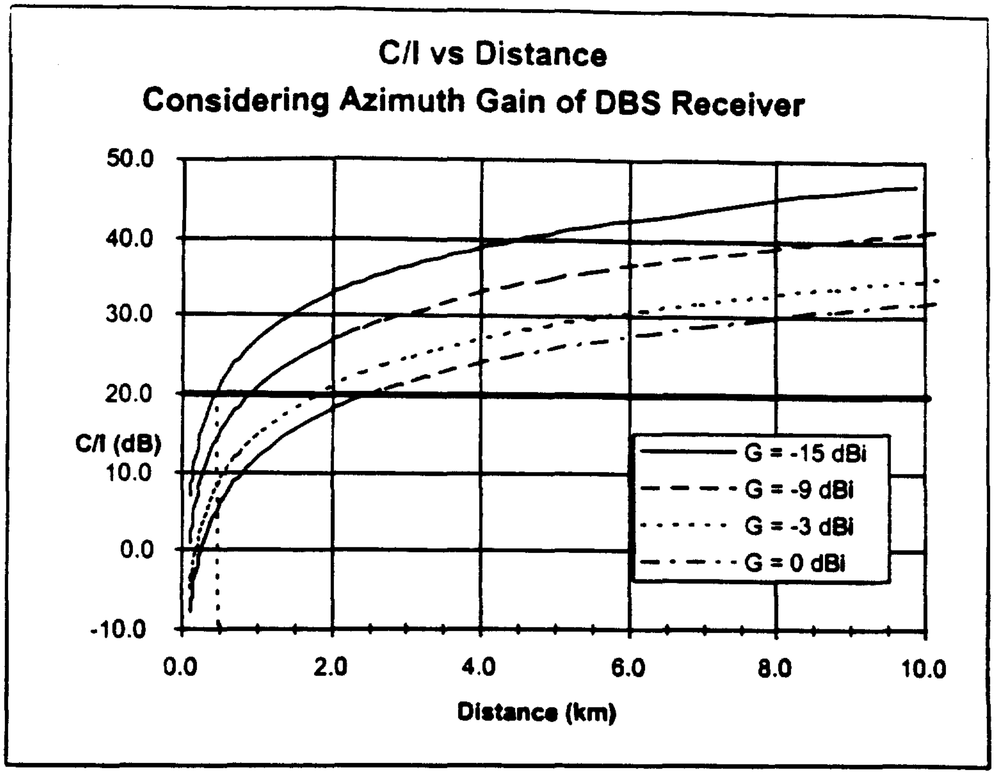

Figure 1-3

In Figure 1-3, DBS users whose receive antennae are pointed substantially away from a co-frequency terrestrial transmission now fall outside the mitigation zone. Accounting for variations in DBS antenna discrimination would result in ensuring an acceptable C/I value as close to the Northpoint transmitter as 0.5 km.[4]

Using the Northpoint Technology, the vast majority of DBS users' receive antennas will be pointed away from the Northpoint transmitter. Table 1-1 uses the above percentages in calculating the actual effect on the size of the mitigation zone for all users, given the specific point geometry of their receive dish:

[4] Figure 1-3 is valid on the boresight of the Northpoint transmitter, at zero meters above ground level, without accounting for horizontal discrimination of the Northpoint transmitter, nor any interference mitigation techniques. These will be discussed in sections 2 and 3 of this report.

Table 1-1. Percent of service area in potential mitigation zone

DBS Horizontal Antenna Gain.	dBi	0.0	-3.0	-9.0	-15.0	Total
Maximum RSSi Allowed (C/I = 20 dB)	dBWi	-142.9	-139.9	-133.9	-127.9	
Minimum Separation	km	2.5	1.8	0.9	0.5	
Service Area (uncorrected)	%	2.5%	1.3%	0.3%	0.1%	
Relative Percent of Horizontal Azimuth	%	16.0%	28.0%	42.0%	14.0%	100%
Percent of Service Area Affected	%	0.40%	0.35%	0.13%	0.01%	0.9%

Thus, simply by accounting for azimuth of the DBS antenna, the size of any mitigation zone is decreased dramatically: less than 1% of customers in the service area of a Northpoint transmitter could potentially be affected by interference. A visual representation of the relative sizes of the interference zones and service areas is depicted in Figure 1-4, which shows the relatively small size of any potential 1 km mitigation zone.

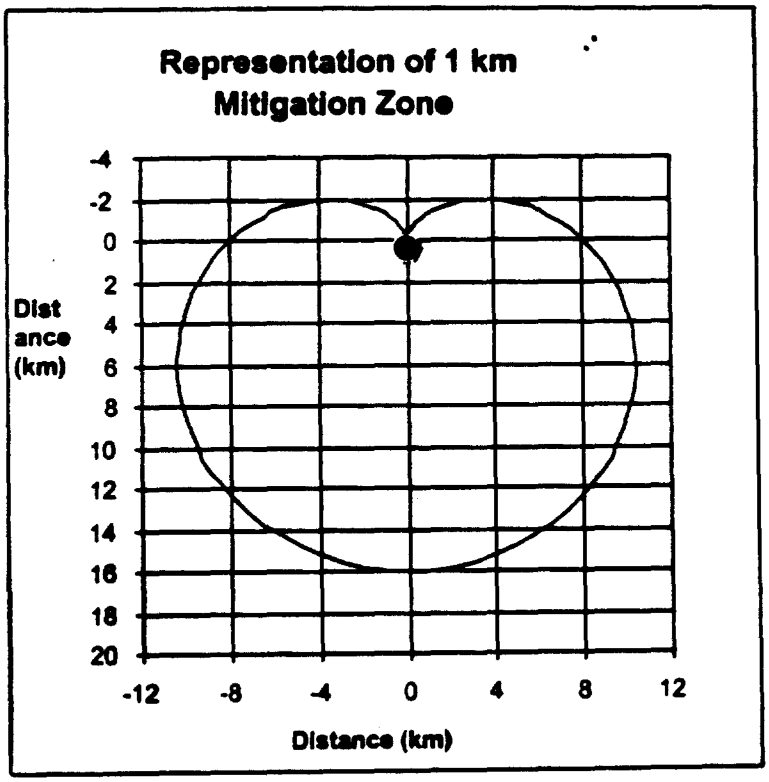

Figure 1-4

Thus, with one simple observation about the horizontal gain pattern of the DBS antenna, it is clear that the only potential effect on DBS receivers DBS is in less than 1.0% of the Northpoint service area. To eliminate interference in this residual area, the Northpoint Technology employs multiple additional interference mitigation techniques, as discussed in Section 2.

Section 2. Interference mitigation through directional broadcast, transmit site selection, vertical plane attenuation, beam tilting and tower height.

The evidence presented in Section 1 demonstrates that DBS antenna rejection will provide a C/I ratio of 20 dB or more in 99 percent of the service area. For the remaining area, Northpoint technology will maintain an RSSi nominally below the suggested DBS interference level through a combination of tower height, vertical plane transmit antenna discrimination and transmission beam tilting/forming techniques.

In Section 1, it was demonstrated that RSSi values below -142.9 dBWi protect all DBS customers. This section will review the following mitigation techniques and show how the RSSi can be maintained below DBS interference levels:

- Directional broadcast from the north;
- Tower height above ground level;
- Vertical plane Northpoint transmitter antenna discrimination;
- Beam tilting of the Northpoint signal;
- Horizontal plane discrimination of the Northpoint signal;
- Placement of the Northpoint transmitter in uninhabited areas; or
- Terrain Blockage.

Additional modification of any affected DBS antenna installations at licensee expense will alleviate any residual interference that would result due to unusual customer antenna placement, off-pointing of the DBS satellite, etc, as discussed in Section 3.

Directional Broadcast: The fundamental characteristic of the Northpoint Technology is the transmission from the north, so as to minimize interference with co-frequency DBS satellite receivers.

Increasing tower height reduces RSSi. Because Northpoint transmitters will be placed on hills, towers or tall buildings, a reduction of the power near the transmitter due to increased path length can be estimated. This is graphically illustrated in figure 2-1. Reduced power levels on the order of 10 dB are seen in the neighborhood of the tower.

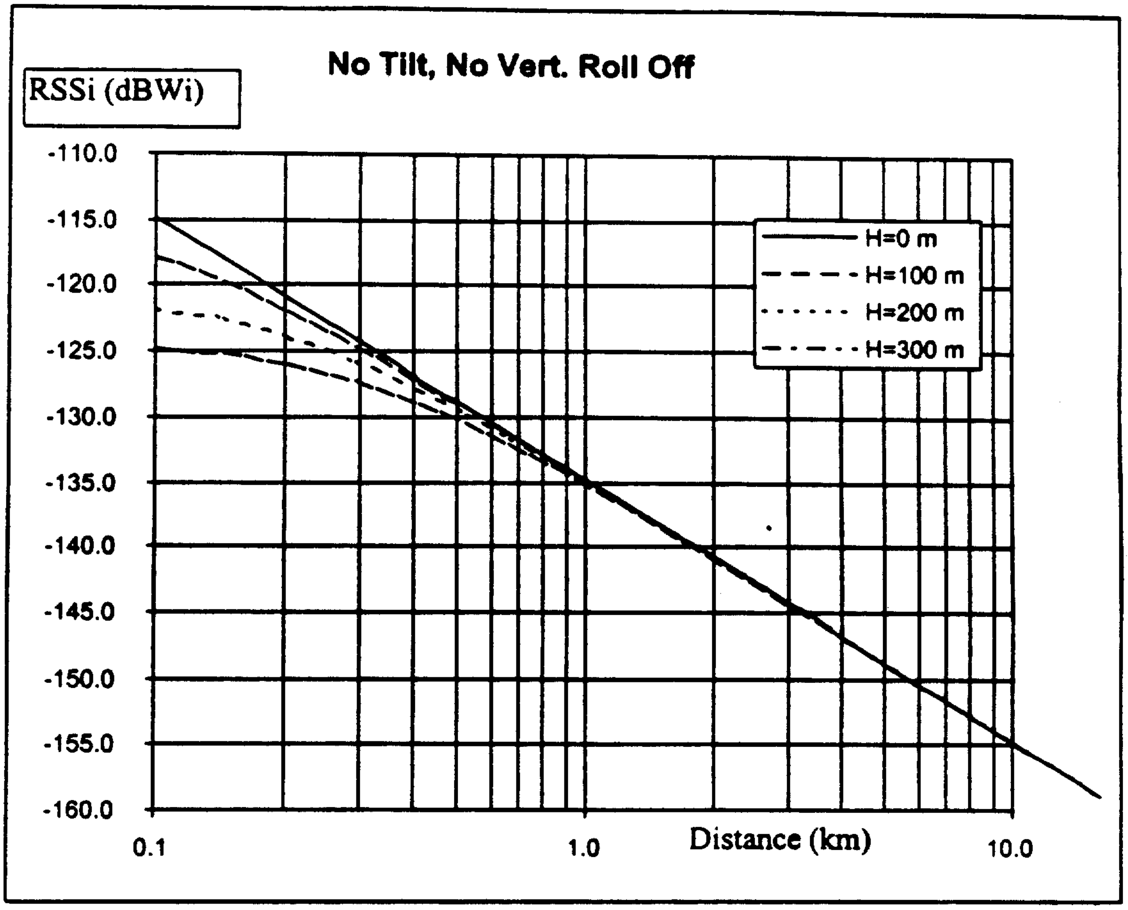

Figure 2-1 RSSi of selected transmitter height above ground level (HAGL)

Discrimination in the vertical plane due to the rapid fall off of the Northpoint transmitter antenna reduces power levels dramatically inside of 3 km. The test antenna used in the Northpoint experiment has a half-power single sided beam width of 9°. A model of the antenna pattern is presented in the DeLawder engineering attachment.

Figure 2-2 demonstrates the power levels for transmitters at various heights above ground level taking into account the vertical antenna pattern. A dramatic reduction in RSSi is seen when this effect is taken into account. The line at -142.9 dBWi shows where the entire DBS service will be fully protected with a 20 dB C/I ratio. With a 200 meter tower installation, only 4 dB of additional attenuation is required to reach this level. Thus, the entire service area is protected to at least a 16 dB C/I ratio, an acceptable level in many circumstances. At this level, there is only the potential for interference to less than 0.5% of the DBS subscribers.

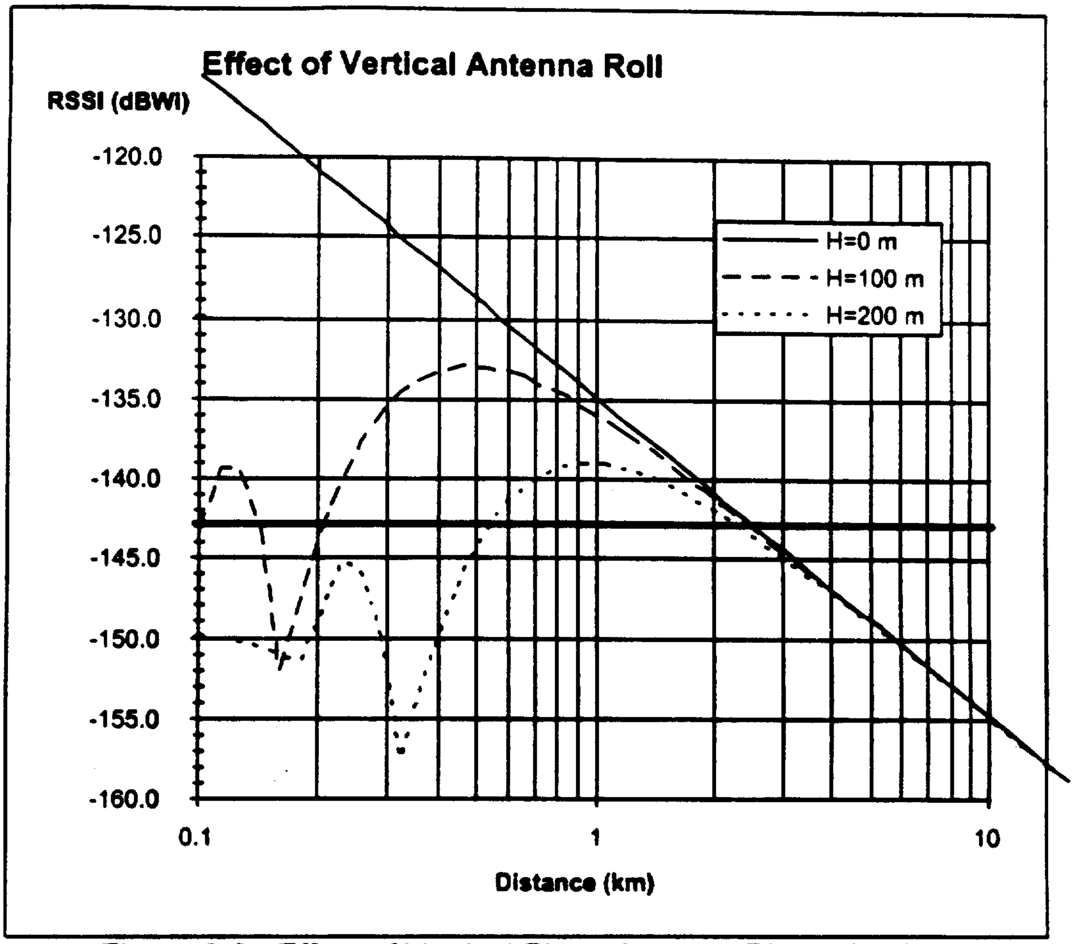

Figure 2-2. Effect of Vertical Plane Antenna Discrimination.

Although the described antenna was employed in experimental testing, the shape of the beam can be improved upon for commercial deployment. Additional beam forming in the vertical plane is also possible beyond that employed in this analysis.

Beam Tilting of the Northpoint Signal. In addition to vertical plane attenuation, Northpoint plans to employ beam tilting to further reduce RSSi levels in the mitigation zone when necessary. As discussed below, a vertical tilt of up to 5 degrees results in a reduction of only 1 dB RSSi at the maximum service distance of 16 km, within the design margin of the Northpoint system while providing additional attenuation in the mitigation zone. Figure 2-3 shows the added effect of beam tilting for a typical Northpoint transmitter height of 150 meters.

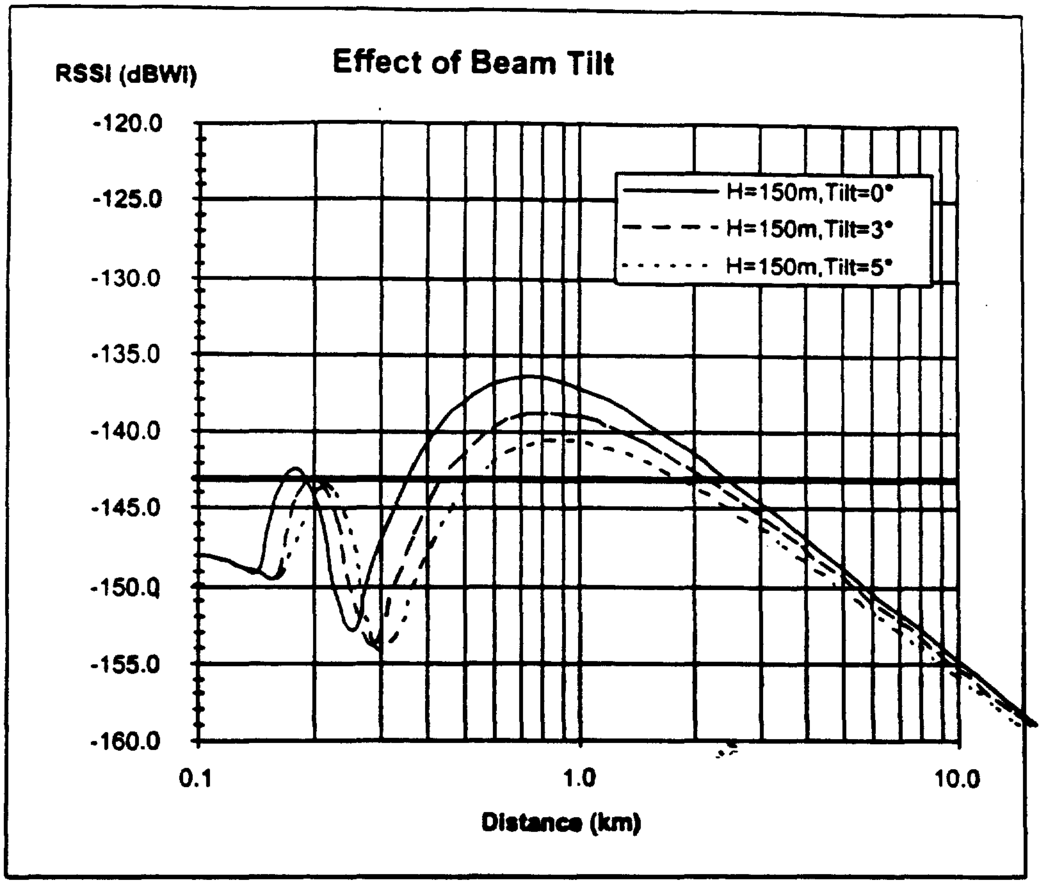

Figure 2-3. Effect of Beam Tilting.

The line at -142.9 dBWi shows where all DBS customers will be fully protected. In this analysis, which considers a 150 meter installation and 5 degrees of beam tilt, only three dB of additional attenuation would be needed to reach the level where all customers will be protected at a C/I of 20 dB. All DBS customers are protected to a level of 17 dB C/I ratio. At this level, there is only the potential for interference to less than 0.25% of DBS subscribers.

A combination of these mitigation techniques will protect all DBS customers. The RSSi for a Northpoint antenna at 200 meters with 5 degrees of tilt is shown as Figure 2-4. As can be seen, the cumulative effects of these mitigation techniques has a dramatic impact on the size of the mitigation zone. In this example, *all* DBS subscribers will be protected at a C/I ratio of 20 dB or better. Figure 2-4 illustrates the corresponding C/I values for various DBS antenna rejection levels.

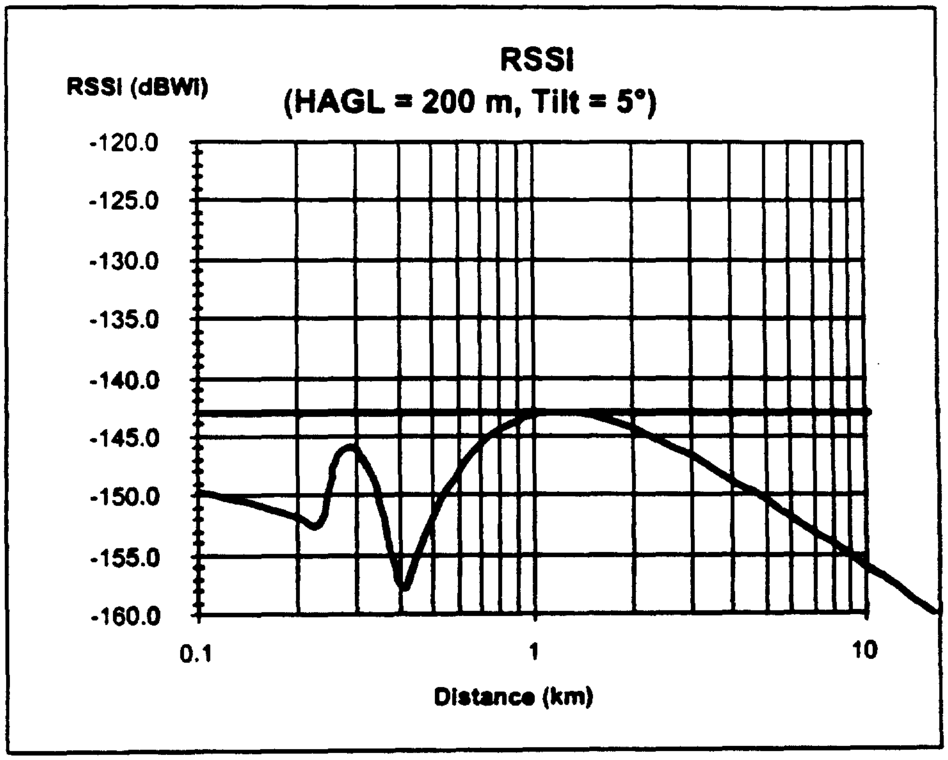

Figure 2-4. Combination of Effects.

Figure 2-5 shows that the entire service area will be protected at a C/I level greater than 20 dB, and the majority will have protection ratios in excess of 30 dB.

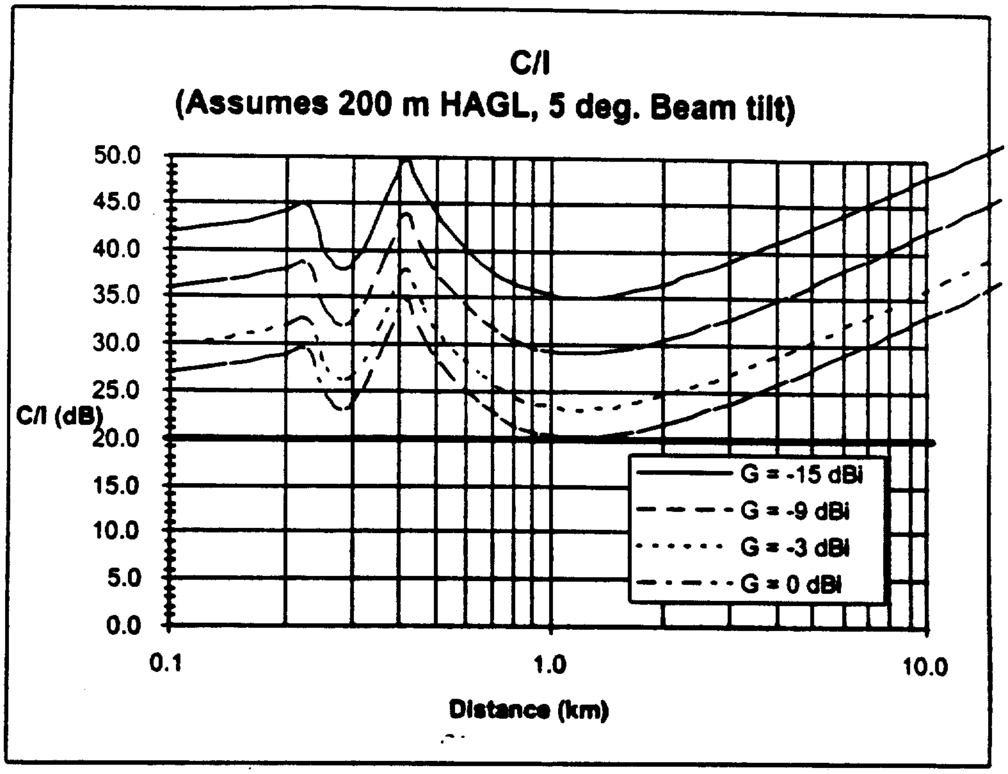

Figure 2-5

The horizontal plane discrimination of the Northpoint signal. The analysis above does not even take into account variations that exist in two dimensions, such as the effects of horizontal attenuation of the Northpoint transmitter and variations in the respective satellite positions of the DBS systems. In order to provide an accurate two dimensional representation, a series of plots were developed by DeLawder Communications, Inc. using EDX Engineering, Inc.'s **MSITE™** (version 3.0) commercial computer software program. This software was used in studies accounting for both vertical and horizontal plane antenna discrimination for the Northpoint transmit antenna and the DBS receive antenna in the determination of C/I ratio values. This work is attached as "Engineering Exhibit prepared by DeLawder Communications, Inc."

Potential interference in Austin, Texas. For a typical Northpoint installation in Austin Texas, interference C/I ratios were calculated for several DBS look angles to the GSO arc, using actual DBS satellites in operation. Because the software used to generate these figures also accounts for the horizontal discrimination of the Northpoint transmitter (using the antenna pattern in the attachment), the analysis yields a much more accurate representation of the potential mitigation area. In many cases, the combination of effects has virtually eliminated the mitigation zone.

Note that the actual antenna pattern used, both in testing and in the EDX analysis, is slightly less powerful in the side and back lobes than a standard cardiod. The corresponding service and potential mitigation areas are smaller. The service area of the antenna tested is 240 km^2, 20% smaller than the analysis presented herein.

Terrain Blockage. It is important to note that in any mitigation zone that might exist, attenuation due to terrestrial blockage will also contribute in reducing interference.[5] Importantly, a significant percentage of DBS installations are below the roof line. The antenna manufacturer, as well as DBS receiver manufacturers Sony and RCA, recommend roof-top installations only as a last resort. Attenuation due to terrestrial blockage will also protect a significant percentage of DBS users. If one assumes, conservatively, that only half (50%) of the possible installations in the mitigation zone are below roof top (lack of line of sight), this further reduces the number of affected DBS subscribers in any mitigation zone.

[5] DIRECTV agrees that "Natural shielding will occur and reduce interference levels, but cannot be counted upon" Terrestrial Interference in the DBS Downlink Band op. cit. p 23. Northpoint agrees and asserts that where natural shielding does not protect DBS consumers Northpoint will employ other mitigation techniques to alleviate interference.

Section 3. Residual interference mitigation techniques.

The foregoing sections demonstrate that the Northpoint system will not interfere with DBS receivers. In the unlikely event that it does, the licensee will bear the burden of preventing interference to the few users affected. Specifically, the licensee will modify, upgrade or otherwise protect any affected DBS customer, at its own expense. The techniques employed in these cases include:

- Repositioning poorly pointed DBS antennas to eliminate pointing losses;
- Replacing the standard DBS antenna with one with better rejection characteristics;
- Relocating DBS subscriber receivers away from line-of-sight.
- Shielding to protect DBS customers.

The use of these techniques can add several dB of additional margin.

Section 4. Improvement of conservative assumptions.

In the prior sections, Northpoint has demonstrated that the potential mitigation zone where interference into DBS receivers might be a concern are quite small, and may in fact not interfere. This section notes that the interference analysis was generated using DBS industry-supplied conservative figures. In actual fact, real-world interference is likely to be less. This should provide the Commission, and the DBS industry, with an extra margin of comfort with Northpoint's technology.

The interference targets on which Northpoint based its analysis could be improved upon in an open industry dialog. Northpoint would welcome such discussions. For example, there is room for improvement in the C/I figure of 20 dB. Additionally, in many parts of the country, the clear sky C/N value for DBS receivers will be higher than 11.4 dB. To the extent this is true, a C/I figure lower than 20 dB would still ensure high-quality reception by DBS users.

Improvements in the C/I ratio. In the baseline interference budget, a value of C/I of 20 dB was used. Each 3 dB improvement reduces the potentially affected service area by 50% or more. Two respondents, Tempo and Echostar, indicated that C/I ratios of 19 - 20 dB, or greater, would be necessary to facilitate sharing. With the advent of digital technology, interference ratios of better than 20 dB can be demonstrated not to cause signal degradation, if only because interference between digital carriers normally is less severe than between analog carriers.

Carrier Offsets. Moreover, it is possible to reduce interference through carrier offsets. ITU-R Study Group 11 document 11/93(Rev 1.), 23 May 1997, Draft New Recommendation ITU-R BO.[EEE/11], Protection Masks and Associated Calculation Methods for interference into Broadcast Satellite Systems Involving Digital Emissions, approved in the last Radiocommunication Assembly, demonstrates that offset carriers can result in significant reductions to the effective C/I ratio. In the example cited in ITU-R-11/93, an offset of 7 MHz would yield about a 2-4 dB reduction in interference. With the Northpoint technology, a 7 MHz horizontally polarized carrier offset is possible to both left and right circular DBS polarizations. However, for the purposes of the foregoing analysis, these effects have not been accounted for; further analysis would yield more favorable sharing criteria.

Higher DBS Clear Sky ratio. A 20 dB C/I value relies upon the C/N value of 11.4 dB cited by DIRECTV on page 5 of its report to the Commission as a typical DIRECTV link budget value. However, as the FCC well knows, the typical value for DBS C/N used in the baseline interference budget will vary depending on: (1) where the user is, in relation to boresight and edge of beam; and (2) the actual value of the clear sky C/N where the user is located. ITU-R 4-9-11/46, shows current typical edge-of-coverage EIRP values in operation in Region 2 between 48 and 52 dBW, which yield edge of coverage clear sky C/N values between 11 and 15 dB. If edge of coverage is 3 dB down from peak, the corresponding clear sky boresight C/N values would be between 14 and 17 dB, and the C/I of the Northpoint system could be 3-7 dB lower.

DBS C/I protection values cited by respondents. Various respondents proposed a variety of C/I values. Both Tempo and EchoStar indicated a C/I of around 20 dB or greater would be sufficient; some provided no such value, see Table 4-1.

Table 4-1. System and Protection Ratios, figures in dB.

Respondent	C/N required	C/N (Clear Air)	C/I	I/N
USSB	-	-	-	-
EchoStar	-	-	20	-
Tempo	8	-	19	-
PrimeStar	-	-	-	-
DIRECTV	-	11.4	34.4	-23

Northpoint's planned series of experimental tests will refine these numbers, and Northpoint looks forward to working with the DBS industry to reach an agreement on sharing criteria.

Relevant Sources of Protection Criteria. Northpoint also notes that some DBS proponents have provided various suggested protection criteria designed to address interference from sources that bear little relation to Northpoint's proposed fixed and broadcast services. For example, DIRECTV cites a working document in ITU-R JTG 4-9-11 as a source for an I/N of -23 dB derived from ITU-R Appendix 30. This figure was developed to further refine EPFD levels for protection of the BSS from NGSO-FSS systems. Without commenting on the required protection ratios between NGSO-FSS systems and the BSS, Northpoint notes that there are fundamental technical and operational differences between NGSO-FSS systems and the Northpoint FS (point-to-multipoint) or BS systems. These fundamental differences call for different approaches in establishing interference protection ratios. NGSO-FSS systems employ low-orbiting satellites which produce dynamically varying interference power levels, potentially into the main lobe of BSS systems, while terrestrial Northpoint systems will employ fixed EIRP with interference mitigation techniques that will only be received at the BSS backlobe levels.

Relevance of ITU Protection Criteria. Other protection ratios cited in the comments and in ITU-R appendix 30 were developed based upon other inapplicable assumptions:

- The C/I protection ratios were used with the MSPACE interference analysis software to develop the Regional assignment plans for the BSS, using the reference system parameters for typical BSS systems.

- The Plan assumes that ALL BSS assignments throughout the Region have been implemented using exactly those reference parameters, and calculates aggregate interference based upon this assumption.

However, as noted by DIRECTV in ITU-R JTG 4-9-11/46, "it is totally unrealistic to use the reference system parameters that were used for planning fifteen, or even one year ago" and "BSS systems utilize satellite EIRPs lower than the Plans (e.g., 53 dBW vs 60 dBW or more)."[6] In addition, the Plans are not fully populated, or even 20% populated, and the actual EIRP's are 7 dB or more below reference system values used to develop for intra- (and inter) system protection ratios. The actual intra-service interference levels will be far below levels already allocated for in BSS system interference budgets.

Another inappropriate assumption was that existing ITU protection ratios were developed to protect analog BSS transmissions from analog interference sources. For the digital transmission in use by all BSS systems in the planned band and proposed for use by Northpoint, the protection ratio will be several dB lower than that used to develop the Region 2 BSS plan in 1983. Note that when Regions 1 and 3 adopted a revised plan at WRC-97, the protection ratio was reduced by more than 7 dB.

These assumptions fail to take into account that in the domestic environment, users of the spectrum, and thus interference levels, can be controlled to a much greater degree than the assumptions ITU-R reference levels were based upon. For example, at 12.2 - 12.7 GHz there are international allocations for the terrestrial BROADCAST, FIXED and MOBILE services, as well as the BSS and NGSO-FSS services, whereas domestically, there are currently no allocations to the BS, MS or FSS services. U.S. BSS providers can thus expect far greater protection from interference simply due to the relative scarcity of co-frequency systems.

Thus, in sum, the differences between the interference environment assumed in AP 30/30A and the actual environment in the U.S. with today's digital technology , seriously calls into question the application of ITU-R inter-service and intra-service protection ratios in the domestic arena.

[6] JTG 49-9-11/46, page 2

Section 5 - Conclusion

This appendix has demonstrated that the Northpoint Technology can share the 12.2 - 12.7 GHz band with DBS systems. Even based on preliminary analysis, Northpoint will provide an adequate C/I ratio to more than 99 percent of the DBS subscribers in its service area, taking into account the lower gain of DBS receivers off-azimuth. However, Northpoint Technology employs directional broadcast techniques to reduce and ultimately even eliminate the mitigation zone. Moreover, Northpoint licensees will be able to use several techniques to ensure that non-typical installations are also not adversely affected. Northpoint looks forward to working with the DBS industry, including in its upcoming second phase of experimental testing, to ensure that accurate protection ratio numbers are utilized.

Appendices: Link budgets and sample calculations.

These appendices provide reference data for the foregoing conclusions about sharing in the 12.2-12.7 GHz band.

Table A-1. Northpoint Technology Sample Link Budget.

Line	Units	Source/Calculation	Item	Symbol	Value
1	MHz		Channel Bandwidth	B	24.0
2	GHz		Frequency	f	12.5
3	%		Availability		99.7%
4	dBW		Transmit Power	P	-25.0
5	Watts		Transmit Power	p	0.003
6	dB		Line Losses	Ll	-2.5
7	dBi		Transmit Gain	Gt	10.0
8	**dBW**	**P+Ll+Gt**	**EIRP**	**EIRP**	**-17.5**
9	dBm		EIRP (dBm)	EIRPdBm	12.5
10	km		Path Length	D	16.0
11	dB	-114.3-20*log(D)	Path Loss	Pl	-138.4
12	dB		Fade Margin	Fm	-2.0
13	dB		Atmos	Atmos	-0.1
14	dB		Rain Margin	Rain	-1.5
15	**dBW**	EIRP+Pl+Fm+Atmos+Rain	**RSSI**	**RSSI**	**-159.5**
16	dBm		Isotropic RSS (dBm)	RSSI dBm	-129.5
17	dBi	45 cm antenna	Receive Antenna Gain	G	34.0
18	dB		Pointing Loss	Ploss	-0.5
19	dBW	RSSI+G+Ploss	C Received	Crec	-126.0
20					
21	°K		System Temp	t	120.0
22	dB-°K	10*log(t)	System Temp	T	20.8
23	dB/K	G-10*log(T)	G/T	G/T	13.2
24	dB/K	Constant	Boltzmans	k	-228.6
25	dB	k+10*log(TB*10e6)	Noise Figure kTB	N	-134.0
26					
27	dB	C-N	Theoretical C/N Received	C/N	8.0
28	dB	QPSK at 10e-04 BER	C/N Required	C/Nreq	8.0
29	dB	C/N-C/Nreq	System Margin	Margin	0.0

Line 1 — Channel Bandwidth. Northpoint has options of employing various channel bandwidths between 1 and 24 MHz. The channel bandwidth of 24 MHz represents a worst case for interference calculations. For example, three 8 MHz carriers would required the same power as one 24 MHz carrier, and the power in the 24 MHz DBS noise bandwidth would be equal

Line 2 — Frequency, center frequency of the 12.2 - 12.7 GHz band.

Line 3 — Availability is based on outage values of about 26 hours per year.

Lines 4-5 Power of -25 dBW sufficient to close the link.

Lines 7-9 While higher or lower transmit gains or EIRP's may be employed in individual applications, the RSS levels will remain nominally below interference levels through the variety of techniques stated in the text.

Line 10 Service distance on boresight.

Line 12 2 dB of Fade margin.

Line 13 0.1 dB of atmospheric attenuation is identified for oxygen and water vapor absorption as a seasonal and typical height above mean sea level average.

Line 14 ITU-R PN.530-5, Rain Zone E, see sample calculation in Table A-3 below.

Line 17 A nominal gain of 34 dBi is used. Higher gain antennas may be employed in different rain regions or specific applications.

Line 28 A nominal C/N requirement of 8.0 is used in the system design. Because Northpoint will employ the same subscriber equipment for downconverting and decoding as the DBS industry, C/N values between 5 and 8 dB can be used. These levels were also verified through testing.

Based on the foregoing, Northpoint has developed its preliminary interference budget.

Table A-2. Preliminary Interference Budget.

Line	Units	Calculation	Item	Symbol	Value
1	GHz		Frequency	f	12.5
2	dB		DBS Clear Sky C/N	C/N	11.4
3	dB/K		DBS G/T	G/T	13.0
4	dBi	45 cm dish	DBS G	G	34.0
5	°K	10^((G-G/T)/10)	DBS T	T	125.9
6	MHz	DBS Noise Bandwidth	DBS B	B	24.0
7	dBW		DBS Noise Figure	N	-133.8
8	dB		Pointing Loss	Ploss	-0.5
9	dBW	C/N+N+Ploss	DBS C received	Crec	-122.9
10	dB		DBS C/I Allow	C/I	20.0
11	dBW	Crec-C/I	Allowable Interference	I	-142.9
12					
13	dBi	Note 2	DBS Antenna Gain towards Horizon	Gain	0.0
14	dBW	I-Gain	Allowable RSSI	RSSI	-142.9

Line	Units	Calculation	Item	Symbol	Value
15	dBW		Interferer EIRP	EIRP	-17.5
16	dB	RSSI-EIRP	Required Attenuation	PLreq	125.4
17	dB		Polarization Isolation	PolIso	-3.0
18	km		Tower Height	HAGL	0
19	deg		Beam Tilting	Beam	0
20	km		Ground Separation Distance	D	2.532
21	km		Total Path	Dtot	2.5
22	dB		Path Loss	PathLoss	-122.4
23	deg		NP Xmit Angle	theta	0.0
24	deg		Xmit Ant. Discrim	XmitDis	0.0
25					
26	dBWi		RSSI	RSSI	-142.9
27	dBWi		RSSI Allowed	Allowed	-142.9
28	dB		Margin		0.0

Line 2. DBS Clear Sky C/N. The value of 11.4 dB was cited in opposition of DIRECTV on page 5 as a typical DIRECTV link budget C/N value. ITU-R 4-9-11/46, shows current typical edge-of-coverage EIRP values in operation in Region 2 between 48 and 52 dBW, which yield edge of coverage clear sky C/N values between 11 and 15 dB. If edge of coverage is 3 dB down from peak, the corresponding clear sky boresight C/N values would be between 14 and 17 dB.

Line 2/3 Typical G/T and antenna gain values are also found in ITU-R 4-9-11/46 and elsewhere.

Line 7 DBS Noise. Figure derived from the relationship N=kTB.

Line 8 Pointing loss. an accounting of 0.5 dB is made for pointing loss. Some respondents argued that pointing losses of 3 dB are required, however Northpoint asserts it can re-point any such poorly pointed DBS antenna.

Line 10 C/I. Two respondents cited C/I ratios of greater than or equal to 19-20 dB. Northpoint asserts that lower C/I values will not cause significant degradation in overall C/I+N. Advances in digital technology continue to refine what is and is not interference. For example, reference ITU-R Study Group 11 document 11/93(Rev 1.), 23 May 1997, Draft New Recommendation ITU-R BO.[EEE/11], Protection Masks and Associated Calculation Methods for interference into Broadcast Satellite Systems Involving Digital Emissions, approved in the last Radiocommunication Assembly. This document demonstrates that for offset carriers significant reductions to the effective C/I ratio can be taken. In the example cited in ITU-R-11/93, an offset of 7 MHz would yield about a 2-4 dB reduction.

With the Northpoint technology, a 7 MHz horizontally polarized carrier offset is possible to both left and right circular DBS polarizations. However, for the purposes of this analysis, these effects have not been accounted for, thus further analysis would yield more favorable sharing criteria.

Line 13 DBS Gain towards horizon. For the purposes of this first look interference budget, a gain of 0 dBi is used. For nearly all azimuthal directions, the gain of the DBS antenna in the horizontal is lower, as much as 16 dBi lower, further reducing potential interference.

Line 14 Interferer EIRP value is taken as typical, lower or higher EIRP values would yield closer or farther separation distances.

Line 17 A polarization isolation of 3 dB was taken. Northpoint uses horizontal or vertical polarization, and DBS is circularly polarized. Half of the Northpoint power would be seen in either polarization.

Lines 18 - 19 The Northpoint transmitter height above ground level and Beam Tilting both are zero in the example, but are used in the calculation of Northpoint antenna discrimination in line 24 and Total Path in line 21.

Line 20 The required maximum ground separation distance was calculated as follows:

RSSI Allowed -EIRP-XmitDis-PolIso=PathLoss

The required path loss in the example:

-142.9-(-17.5)-0-0=-114.33-20*log(D)

Solving for D yields 2.532 km.

Line 21. Total path = (D^2+HAGL^2)^(0.5)

Line 23 theta = arctangent(HAGL/D)

Line 24 XmitDis = F(theta + Beam) according to the envelope provided in the attachment.

Line 26 - 28 Used to verify the RSSI is at or below the allowed level, and the margin is calculated.

This following table is intended to respond to comments by Tempo that over 10 dB of rain margin is required for the Northpoint system. As Table A-3 shows, the six step Calculation Method of ITU-R Rec PN.530-5, yields a required rain margin of only 1.6 dB.

Table A-3
(Assumptions, 20° C Rain Temperature, 12 GHz)

Line	Item	Symbol	Value	Units
1	Step 1	a	0.0168	
2		b	1.200	
3	Step 2	Rain Region	E	
4		R	22.000	mm/hr
5	Step 3	A	0.686	
6	Step 4	d	16.000	km
7		do	25.162	km
8		r	0.611	
9	Step 5	A 0.01%	6.708	
10	Step 6	A 1.0%	0.805	dB
11		A 0.1%	2.616	dB
12		A 0.2%	1.847	dB
13		A 0.3%	1.512	dB

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TELECOMMUNICATIONS ENGINEERING
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CERTIFICATION

1. My name is Robert Combs and I am president of BCA International, an engineering services firm.

2. I have an ME in Systems Engineering from the University of Virginia, 1992; and a BS in Aerospace Engineering (Cum Laude) from the University of Texas (Austin), 1986.

3. I hereby certify that I am the technically qualified person responsible for the preparation of the Technical Annex to Reply Comments of Northpoint Technology.

4. The Annex, and the technical information in the Reply Comments, are complete and accurate to the best of my knowledge.

Dated: May 5, 1998

R Combs

Robert Combs

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DARRYL K. DELAWDER, *PRESIDENT*
DAVID R. MIETUS, *VICE PRESIDENT*

ENGINEERING EXHIBIT PREPARED BY

DELAWDER COMMUNICATIONS, INC.

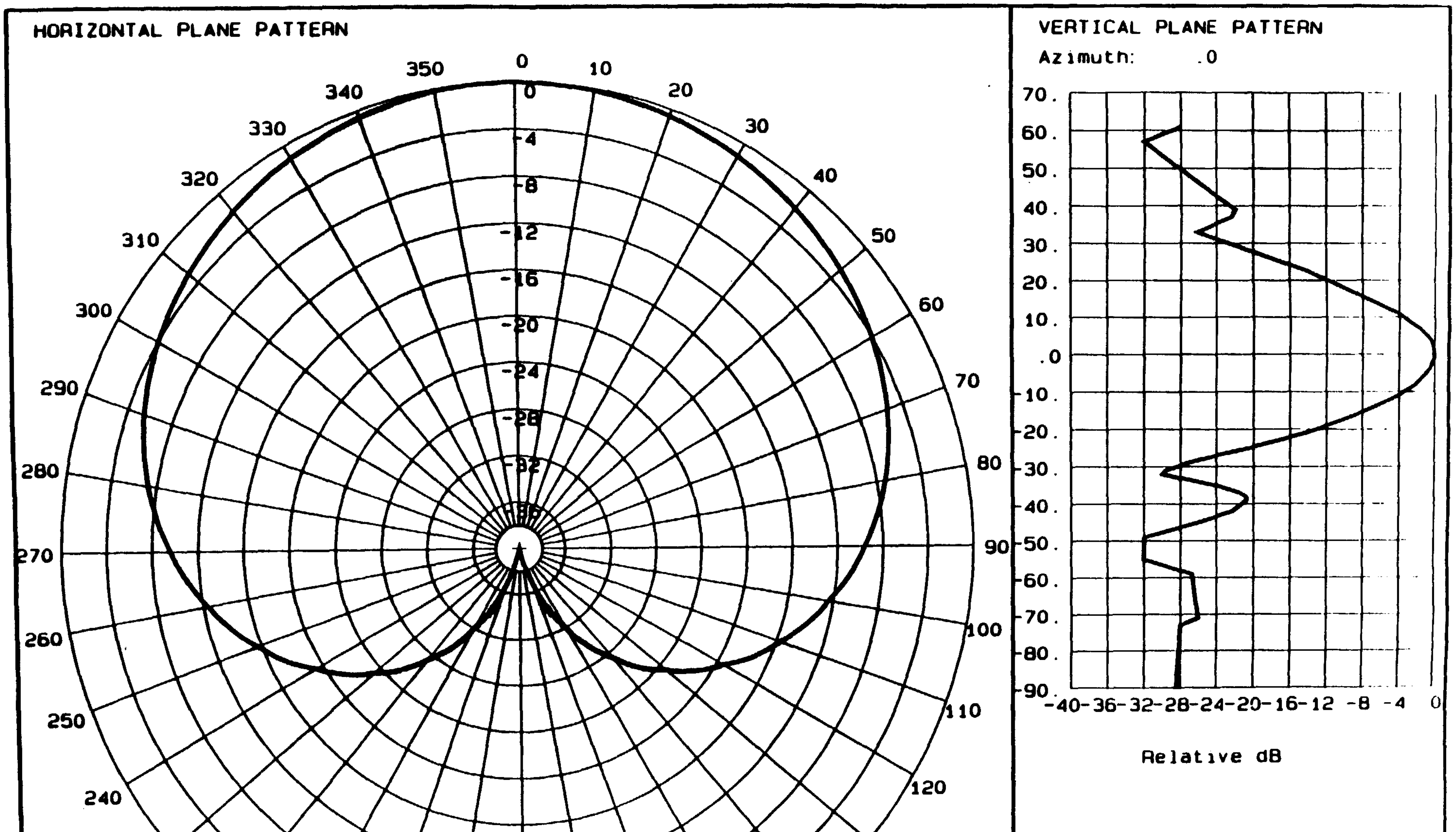
Exhibit 1 NORTHPONT TRANSMIT ANT PATTERN

Total Northpoint Service Area: 240.0. sq. km.
Northpoint Transmitter Location: Austin, TX

MITIGATION AREAS (for C/I of 20 dB)

Exhibit	DBS Rec. Antenna Satellite	Northpoint Rad. Center (m AGL)	Northpoint mech. BT (°down @ AZ)	Exclusion Zone Area (sq. km)	Exclusion Zone Area Percentage (% of Serv.)
2	61.5	0	0 @ 0.0°	1.6	0.67
3	61.5	100	0 @ 0.0°	1.2	0.50
4	61.5	150	0 @ 0.0°	0.8	0.33
5	61.5	150	3 @ 0.0°	0.4	0.17
6	61.5	150	5 @ 0.0°	<0.1	<0.04
7	61.5	200	0 @ 0.0°	0.4	0.17
8	61.5	200	3 @ 0.0°	<0.1	<0.04
9	61.5	200	5 @ 0.0°	<0.1	<0.04
10	101	150	0 @ 0.0°	0.3	0.13
11	101	150	3 @ 0.0°	0.1	0.04
12	101	150	5 @ 0.0°	<0.1	<0.04
13	119	150	0 @ 0.0°	0.7	0.29
14	119	150	3 @ 0.0°	0.4	0.17
15	119	150	5 @ 0.0°	0.1	0.04

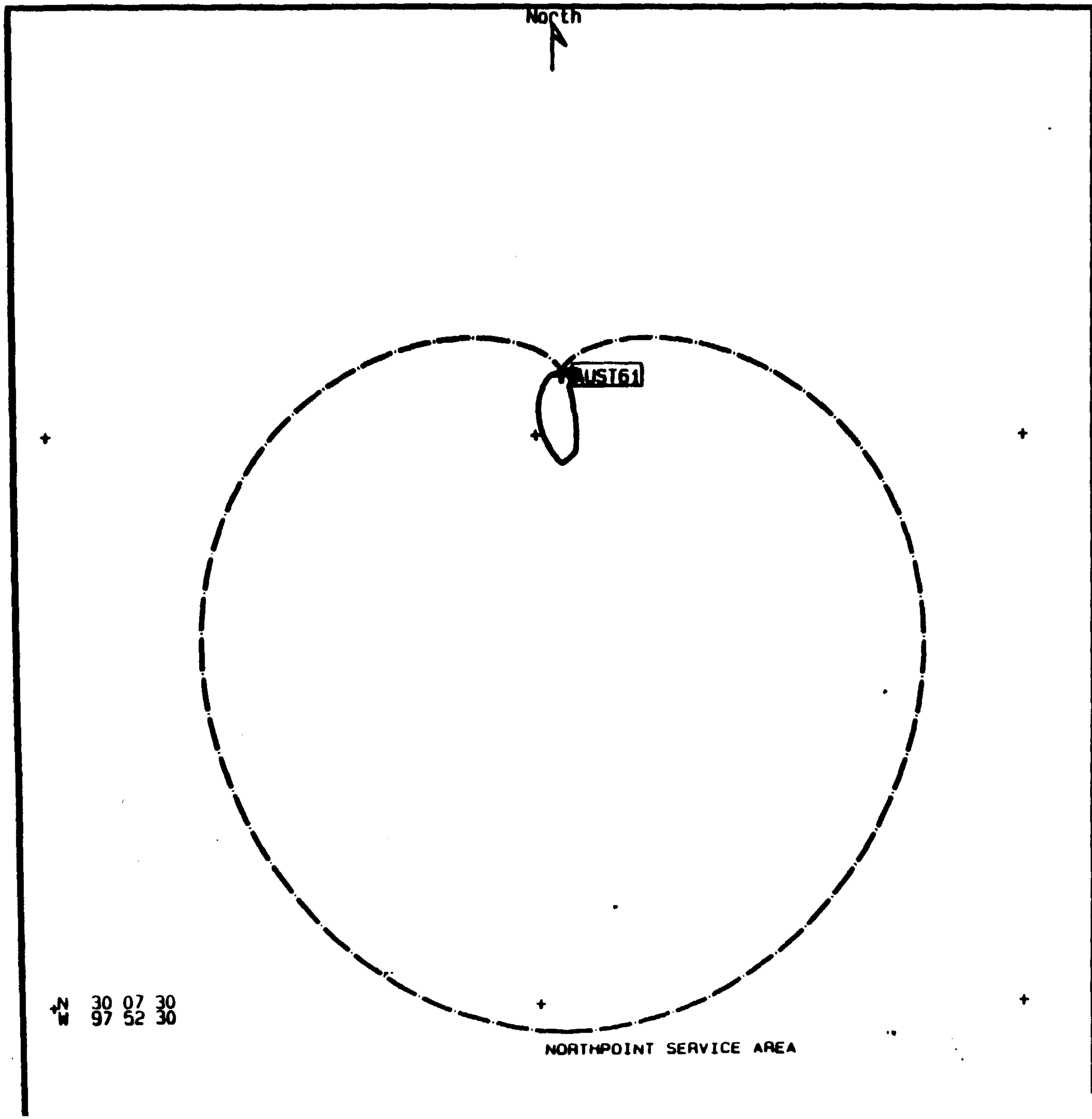
Exhibit 1



Pattern file: pat\aust.pat

Northpoint Transmit Antenna Pattern

Exhibit 2



MSITE (tm) : map\austnew.map

Propagation model: Custom model
Time: 50.00% Loc: 50.00% Margin: .0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: DA-pat\mmds.pat
Height: 2.8 mtrs AGL Gain: -2 2 dBd

Received power (at remote)

-113.0 dBmW

Minimum threshold level: -180.0 dBmW

Site	Ant Elv AMSL (mtrs)	ERPd (dBW)	Ant. Type /Orient.	Coordinates
AUST61 *	144.2		DA-H	N 30 15 48 00
grp: 1	12500.0000 MHz		.0	W 97 44 36 00

KILOMETERS
2 0 2 4 6 8

Austin and 61.5 SAT

Exhibit 3

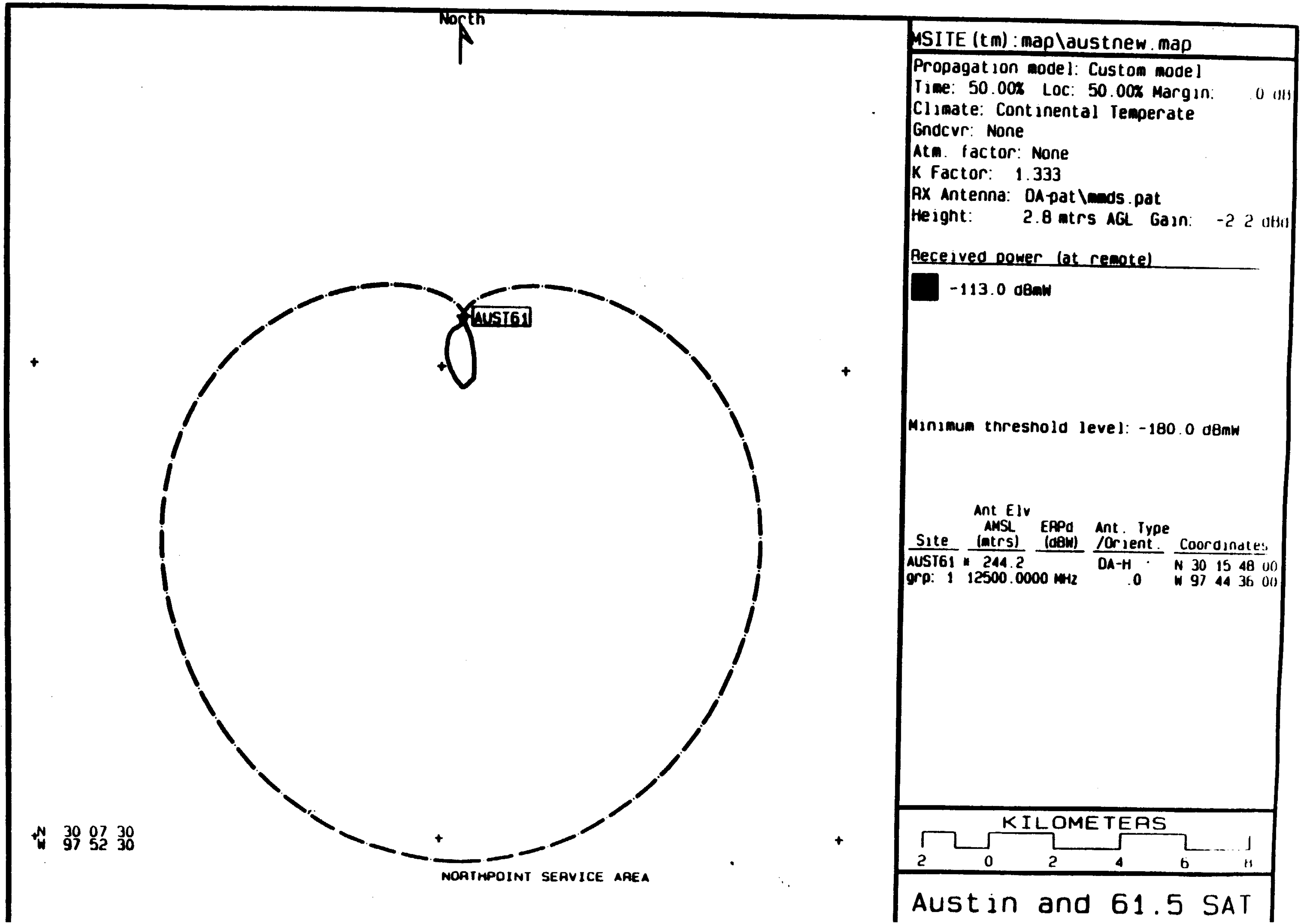
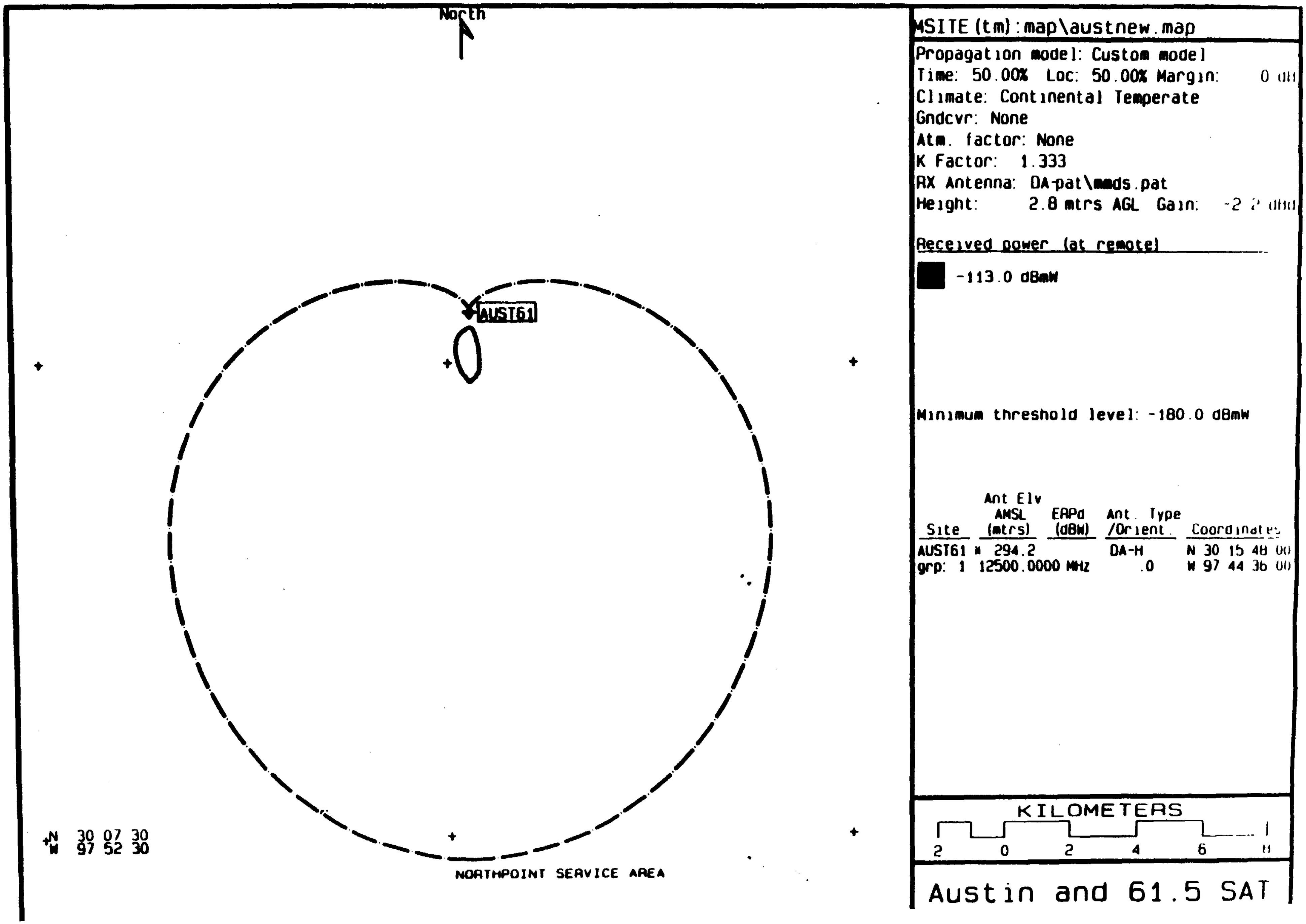
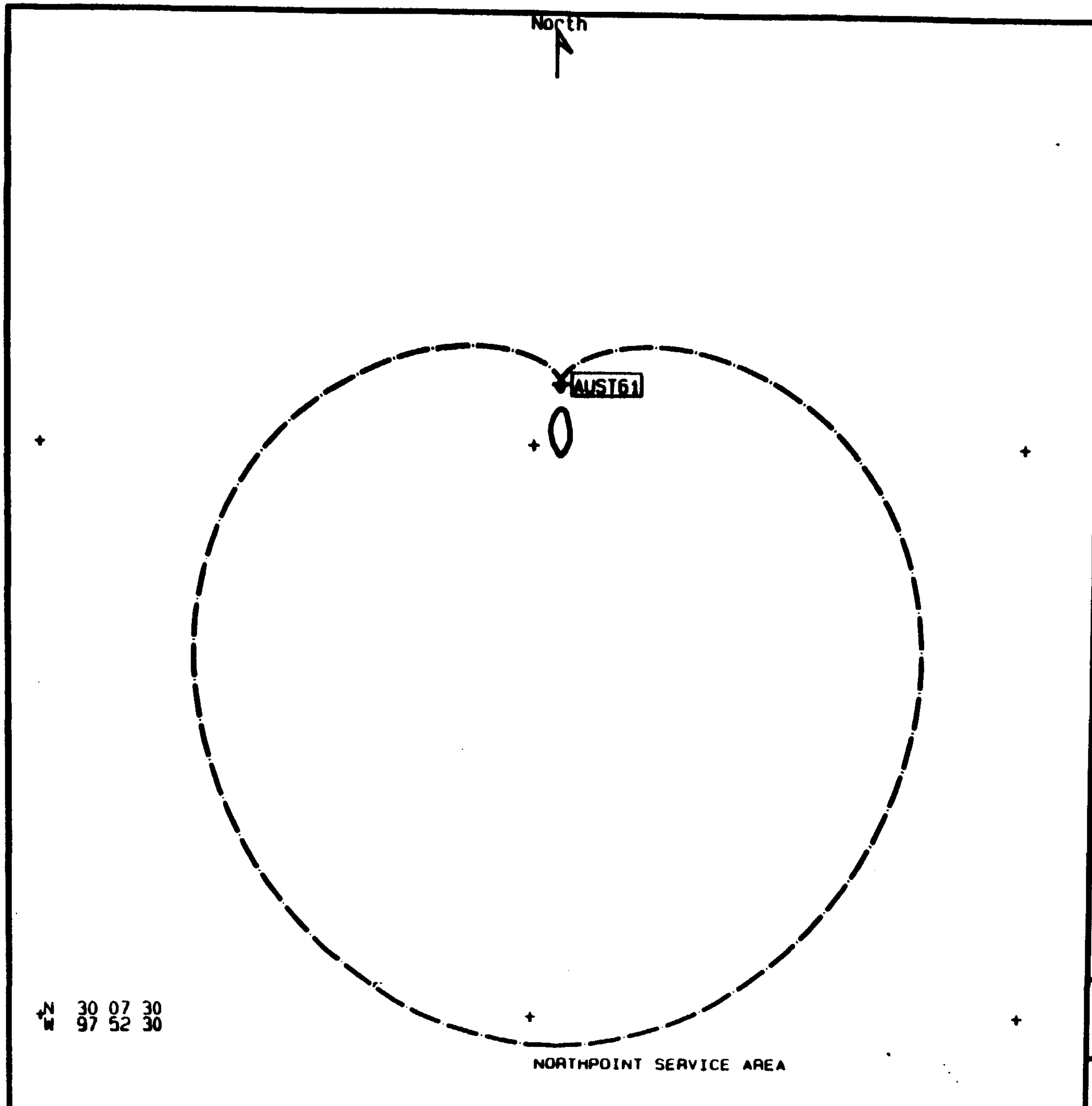

North
AUST61
N 30 07 30
W 97 52 30
NORTHPOINT SERVICE AREA
MSITE(tm):map\austnew.map
Propagation model: Custom model
Time: 50.00% Loc: 50.00% Margin: .0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: DA-pat\mmds.pat
Height: 2.8 mtrs AGL Gain: -2.2 dBd
Received power (at remote)
-113.0 dBmW
Minimum threshold level: -180.0 dBmW
Site | Ant Elv AMSL (mtrs) | ERPd (dBW) | Ant. Type /Orient. | Coordinates
AUST61 * 244.2 | DA-H | N 30 15 48 00
grp: 1 12500.0000 MHz | .0 | W 97 44 36 00
KILOMETERS
2 0 2 4 6 8
Austin and 61.5 SAT

Exhibit 4



North
AUST61
N 30 07 30
W 97 52 30
NORTHPOINT SERVICE AREA
MSITE (tm) : map\austnew.map
Propagation model: Custom model
Time: 50.00% Loc: 50.00% Margin: 0
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: DA-pat\mmds.pat
Height: 2.8 mtrs AGL Gain: -2
Received power (at remote)
-113.0 dBmW
Minimum threshold level: -180.0 dBmW
Site | Ant Elv AMSL (mtrs) | ERPd (dBW) | Ant. Type /Orient. | Coordinates
AUST61 * 294.2 | DA-H | N 30 15 48 00
grp: 1 12500.0000 MHz | .0 | W 97 44 36 00
KILOMETERS
2 0 2 4 6 8
Austin and 61.5 SAT

Exhibit 5



MSITE (tm) : map\austnew.map

Propagation model: Custom model
Time: 50.00% Loc: 50.00% Margin: .0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: DA-pat\mmds.pat
Height: 2.8 mtrs AGL Gain: -2.2 dBd

Received power (at remote)

-113.0 dBmW

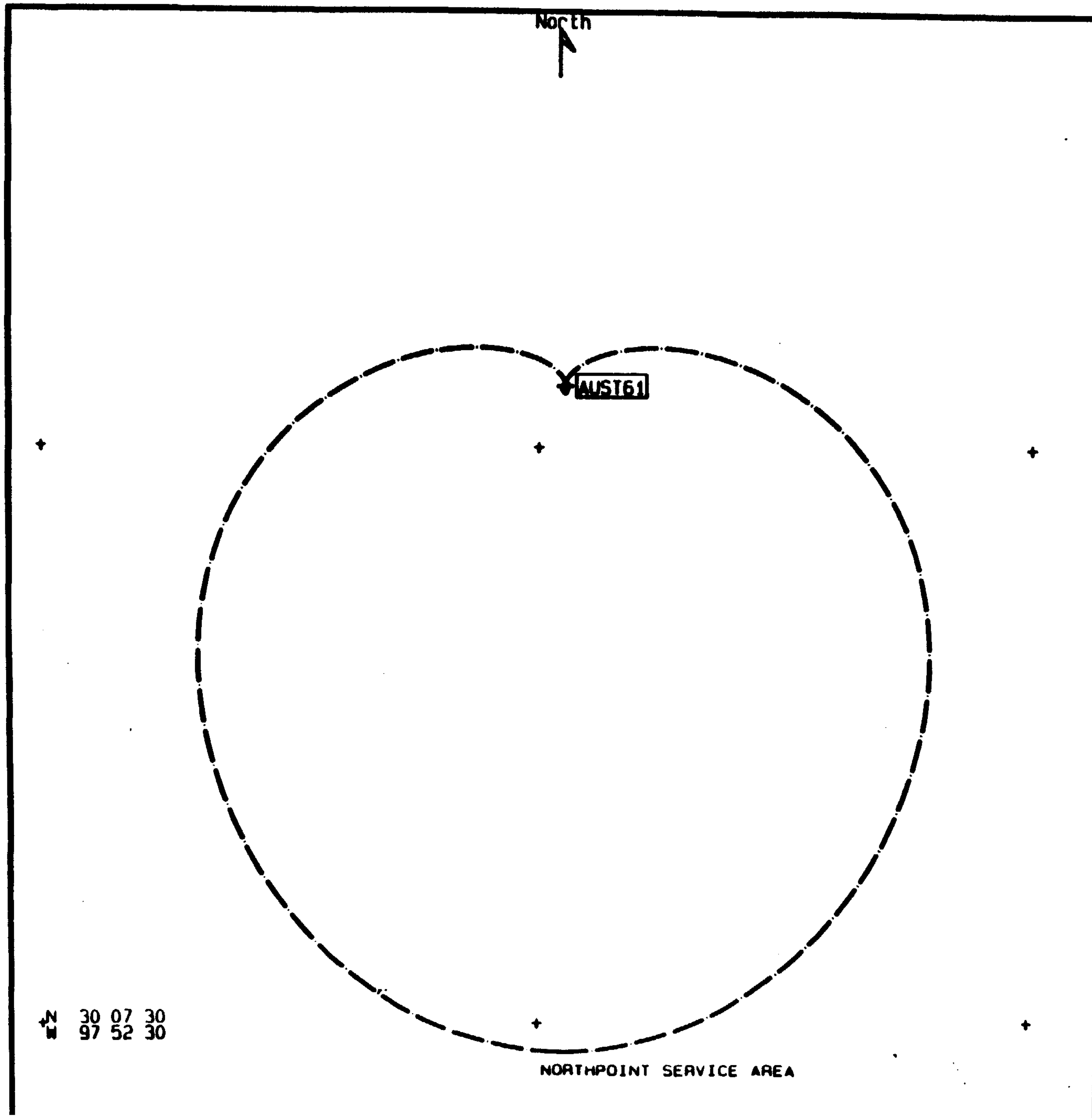
Minimum threshold level: -180.0 dBmW

Site	Ant Elv AMSL (mtrs)	ERPd (dBW)	Ant. Type /Orient.	Coordinates
AUST61 *	294.2		DA-H	N 30 15 48 00
grp: 1	12500.0000 MHz		.0	W 97 44 36 00

KILOMETERS
2 0 2 4 6 8

Austin and 61.5 SAT

Exhibit 6



MSITE (tm):map\austnew.map

Propagation model: Custom model
Time: 50.00% Loc: 50.00% Margin: 0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: DA-pat\mmds.pat
Height: 2.8 mtrs AGL Gain: -2.2 dBd

Received power (at remote)

-113.0 dBmW

Minimum threshold level: -180.0 dBmW

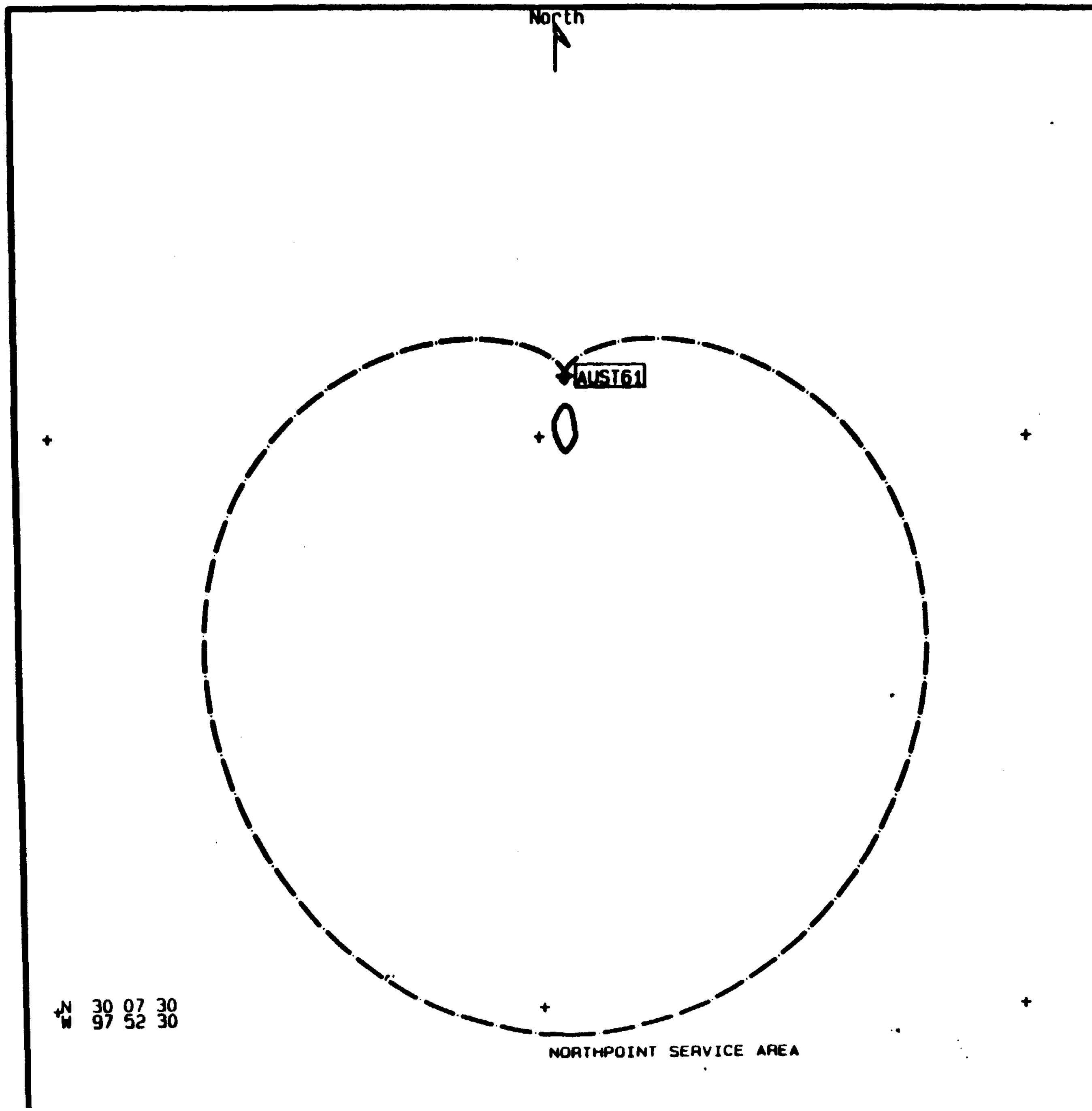
Site	Ant Elv AMSL (mtrs)	ERPd (dBW)	Ant. Type /Orient	Coordinates
AUST61 *	294.2		DA-H	N 30 15 48 00
grp: 1	12500.0000 MHz		.0	W 97 44 36 00

KILOMETERS

2 0 2 4 6 8

Austin and 61.5 SAT

Exhibit 7



MSITE (tm) : map\austnew.map

Propagation model: Custom model
Time: 50.00% Loc: 50.00% Margin: 0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: DA-pat\mmds.pat
Height: 2.8 mtrs AGL Gain: -2.2 dBd

Received power (at remote)

-113.0 dBmW

Minimum threshold level: -180.0 dBmW

Site	Ant Elv AMSL (mtrs)	ERPd (dBW)	Ant. Type /Orient	Coordinates
AUST61 *	344.2		DA-H	N 30 15 48 00
grp: 1	12500.0000 MHz		.0	W 97 44 36 00

KILOMETERS

2 0 2 4 6 8

Austin and 61.5 SAT

Exhibit 8

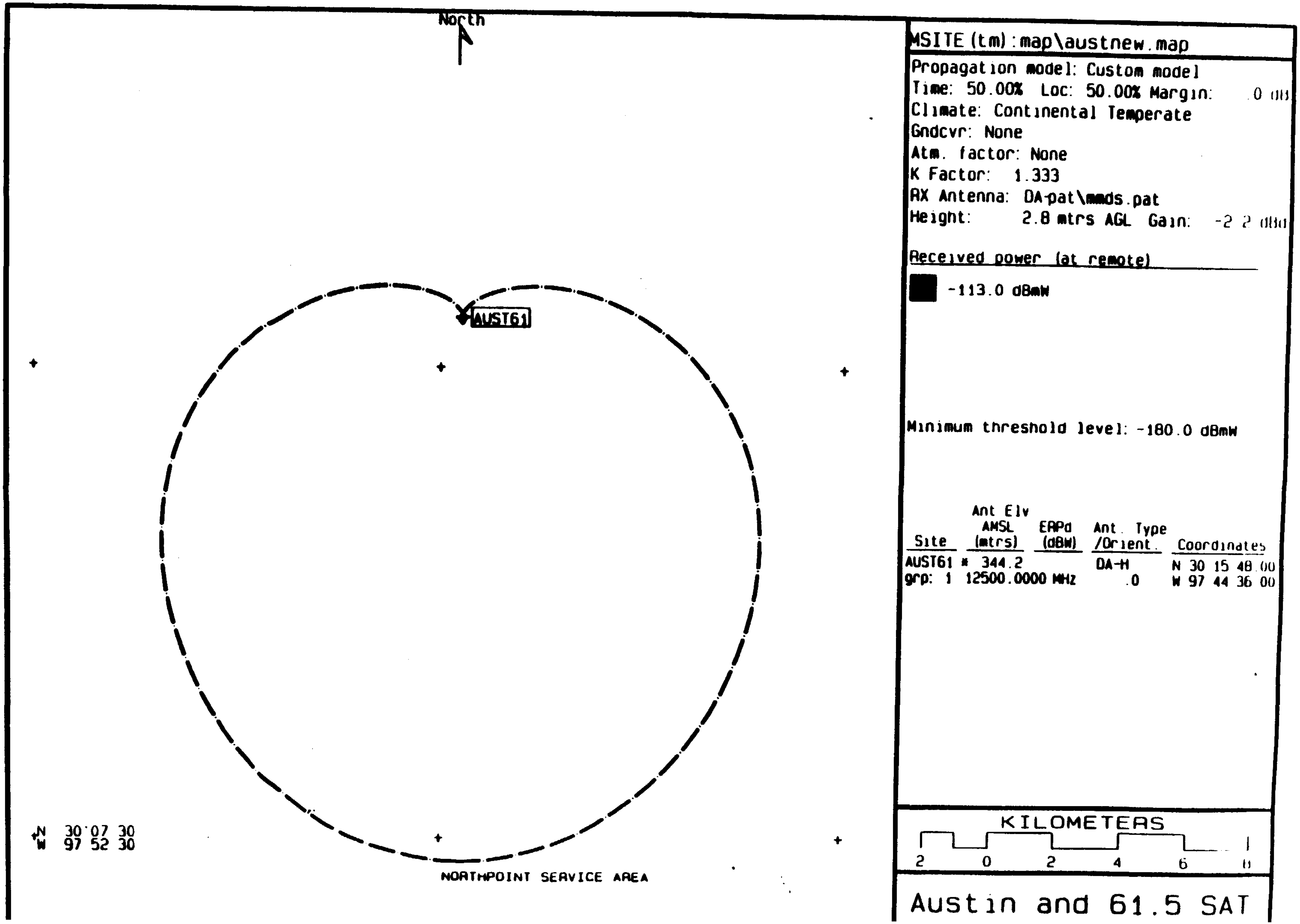

North
AUST61
N 30 07 30
W 97 52 30
NORTHPOINT SERVICE AREA
MSITE (tm) : map\austnew.map
Propagation model: Custom model
Time: 50.00% Loc: 50.00% Margin: .0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: DA-pat\mmds.pat
Height: 2.8 mtrs AGL Gain: -2.2 dBd
Received power (at remote)
-113.0 dBmW
Minimum threshold level: -180.0 dBmW
Site | Ant Elv AMSL (mtrs) | ERPd (dBW) | Ant. Type /Orient. | Coordinates
AUST61 * 344.2 | DA-H | N 30 15 48.00
grp: 1 12500.0000 MHz | .0 | W 97 44 36.00
KILOMETERS
2 0 2 4 6 8
Austin and 61.5 SAT

Exhibit 9

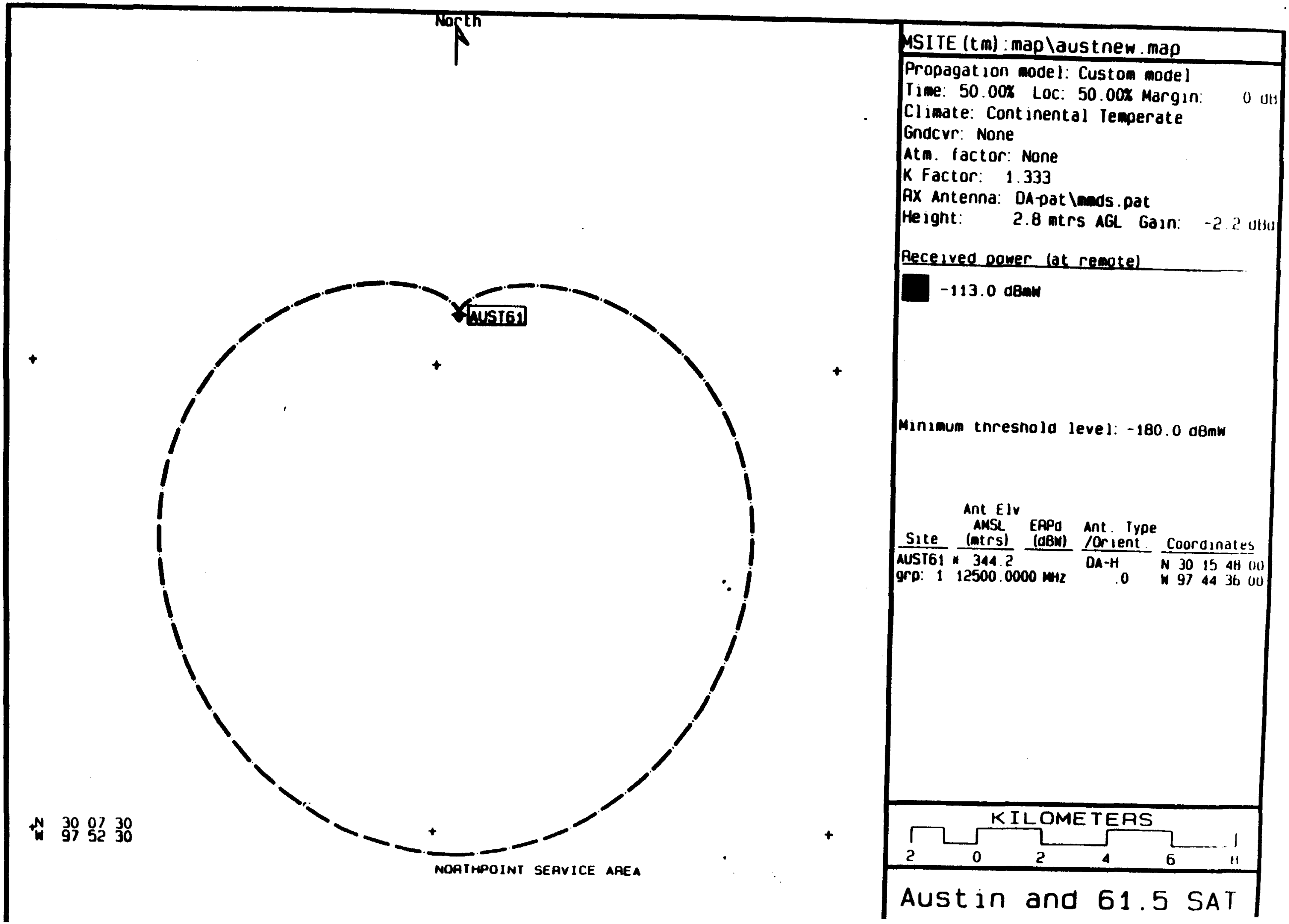
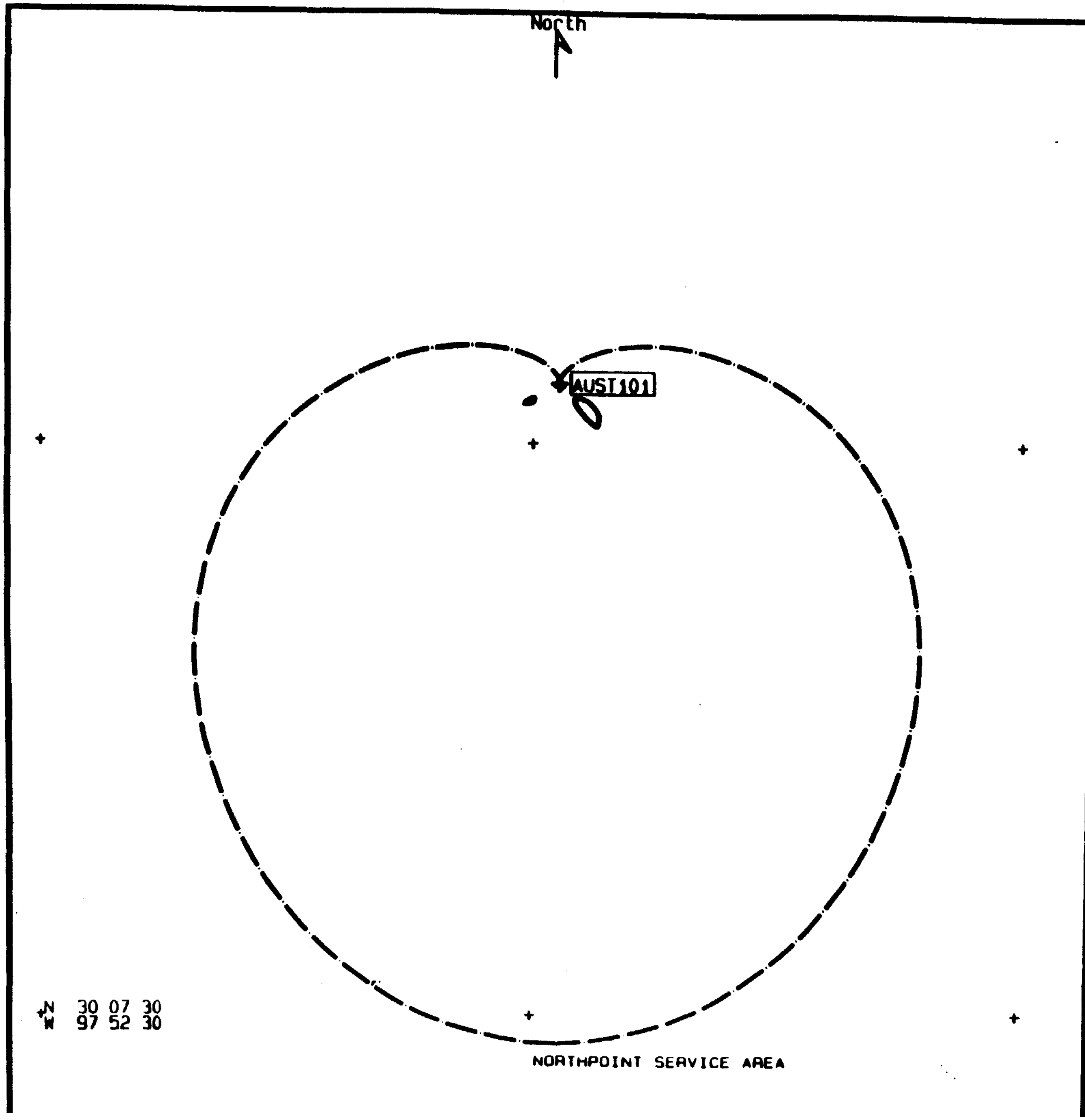

North
AUST61
N 30 07 30
W 97 52 30
NORTHPOINT SERVICE AREA
MSITE (tm) :map\austnew.map
Propagation model: Custom model
Time: 50.00% Loc: 50.00% Margin: 0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: DA-pat\mmds.pat
Height: 2.8 mtrs AGL Gain: -2.2 dBd
Received power (at remote)
-113.0 dBmW
Minimum threshold level: -180.0 dBmW
Site
Ant Elv AMSL (mtrs)
ERPd (dBW)
Ant. Type /Orient.
Coordinates
AUST61 * 344.2
grp: 1 12500.0000 MHz
DA-H
.0
N 30 15 48 00
W 97 44 36 00
KILOMETERS
2 0 2 4 6 8
Austin and 61.5 SAT

Exhibit 10



MSITE(tm):map\austnew.map

Propagation model: Custom model
Time: 50.00% Loc: 50.00% Margin: 0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: DA-pat\mmds.pat
Height: 2.8 mtrs AGL Gain: -2.2 dBd

Received power (at remote)

-113.0 dBmW

Minimum threshold level: -180.0 dBmW

Site	Ant Elv AMSL (mtrs)	ERPd (dBW)	Ant. Type /Orient.	Coordinates
AUST101*	294.2		DA-H	N 30 15 48 00
grp: 1	12500.0000 MHz		.0	W 97 44 36 00

KILOMETERS

2 0 2 4 6 8

Austin and 101 SAT

Exhibit 11

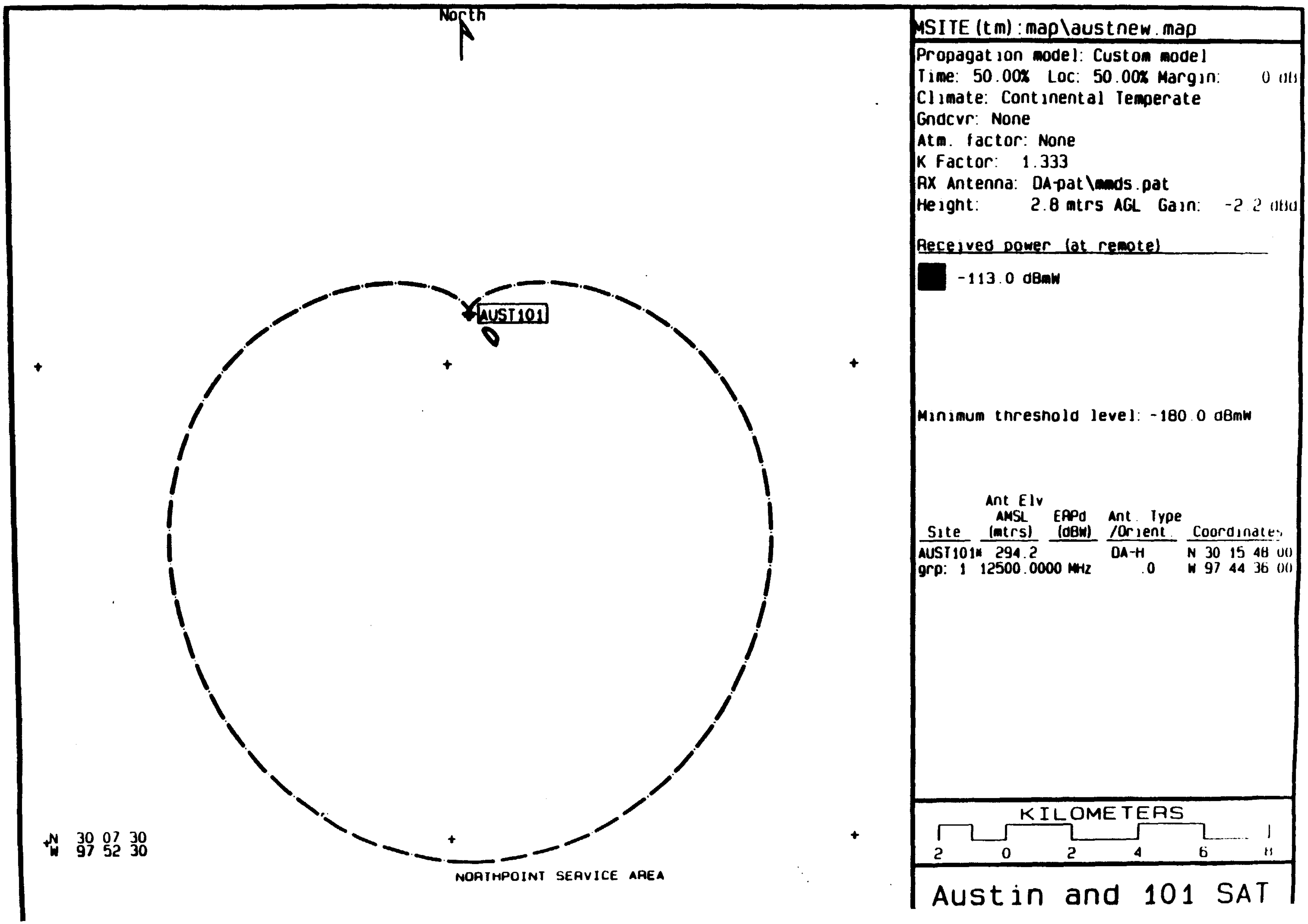
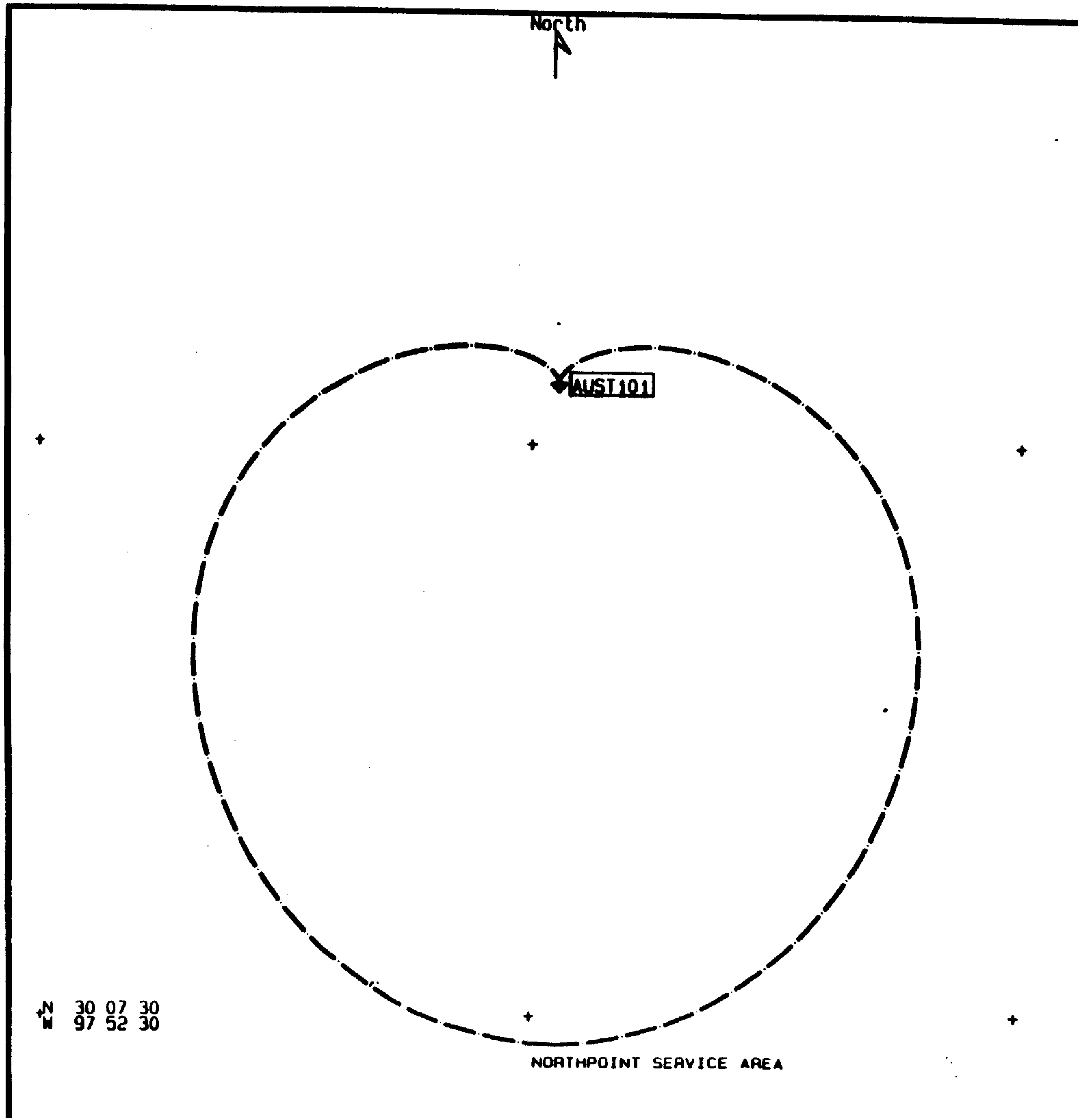

North
AUST101
N 30 07 30
W 97 52 30
NORTHPOINT SERVICE AREA
MSITE (tm):map\austnew.map
Propagation model: Custom model
Time: 50.00% Loc: 50.00% Margin: 0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: DA-pat\mmds.pat
Height: 2.8 mtrs AGL Gain: -2.2 dBd
Received power (at remote)
-113.0 dBmW
Minimum threshold level: -180.0 dBmW
Site | Ant Elv AMSL (mtrs) | ERPd (dBW) | Ant. Type /Orient. | Coordinates
AUST101* 294.2 DA-H N 30 15 48 00
grp: 1 12500.0000 MHz .0 W 97 44 36 00
KILOMETERS
2 0 2 4 6 8
Austin and 101 SAT

Exhibit 12



MSITE (tm) : map\austnew.map

Propagation model: Custom model
Time: 50.00% Loc: 50.00% Margin: 0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: DA-pat\mmds.pat
Height: 2.8 mtrs AGL Gain: -2.2 dBd

Received power (at remote)

-113.0 dBmW

Minimum threshold level: -180.0 dBmW

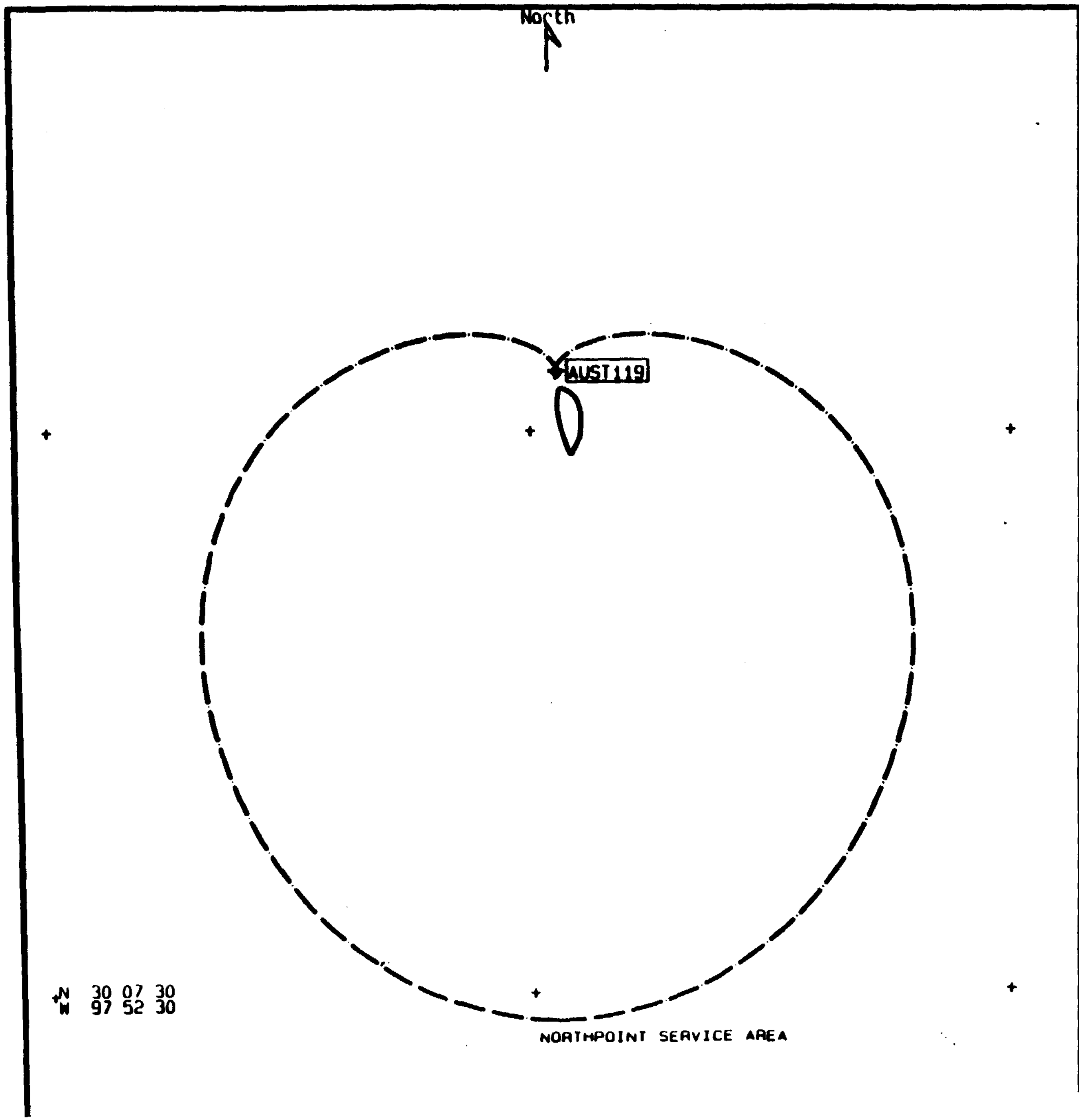
Site	Ant Elv AMSL (mtrs)	ERPd (dBW)	Ant. Type /Orient.	Coordinates
AUST101*	294.2		DA-H	N 30 15 48 00
grp: 1	12500.0000 MHz		.0	W 97 44 36 00

KILOMETERS

2 0 2 4 6 8

Austin and 101 SAT

Exhibit 13



MSITE (tm):map\austnew.map

Propagation model: Custom model
Time: 50.00% Loc: 50.00% Margin: 0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: DA-pat\mmds.pat
Height: 2.8 mtrs AGL Gain: -2.2 dBd

Received power (at remote)

-113.0 dBmW

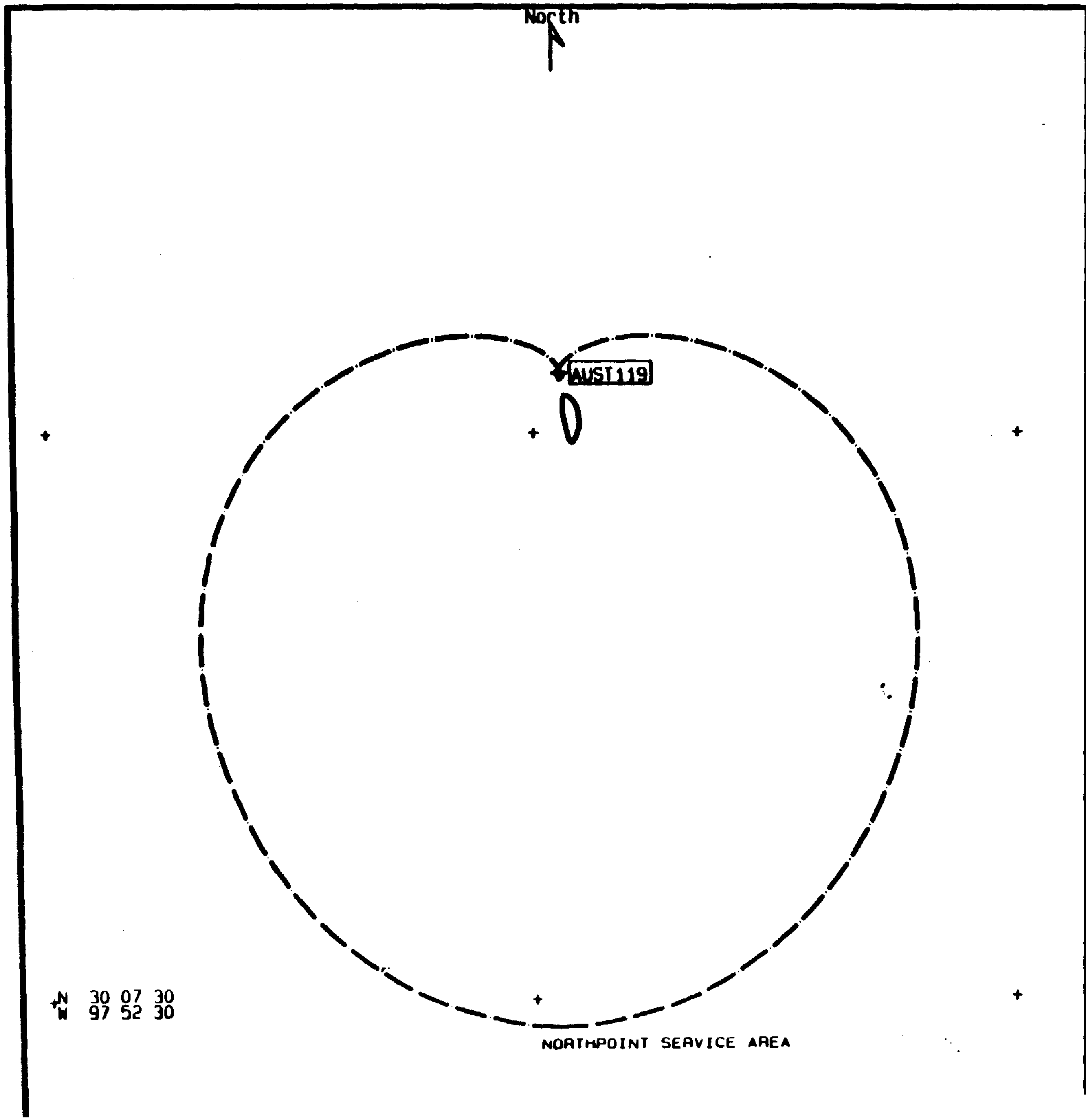
Minimum threshold level: -180.0 dBmW

Site	Ant Elv AMSL (mtrs)	ERPd (dBW)	Ant. Type /Orient.	Coordinates
AUST119*	294.2		DA-H	N 30 15 48 00
grp: 1	12500.0000 MHz		.0	W 97 44 36 00

KILOMETERS
2 0 2 4 6 8

Austin and 119 SAT

Exhibit 14



MSITE (tm) :map\austnew.map

Propagation model: Custom model
Time: 50.00% Loc: 50.00% Margin: 0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: DA-pat\mmds.pat
Height: 2.8 mtrs AGL Gain: -2.2 dBd

Received power (at remote)

-113.0 dBmW

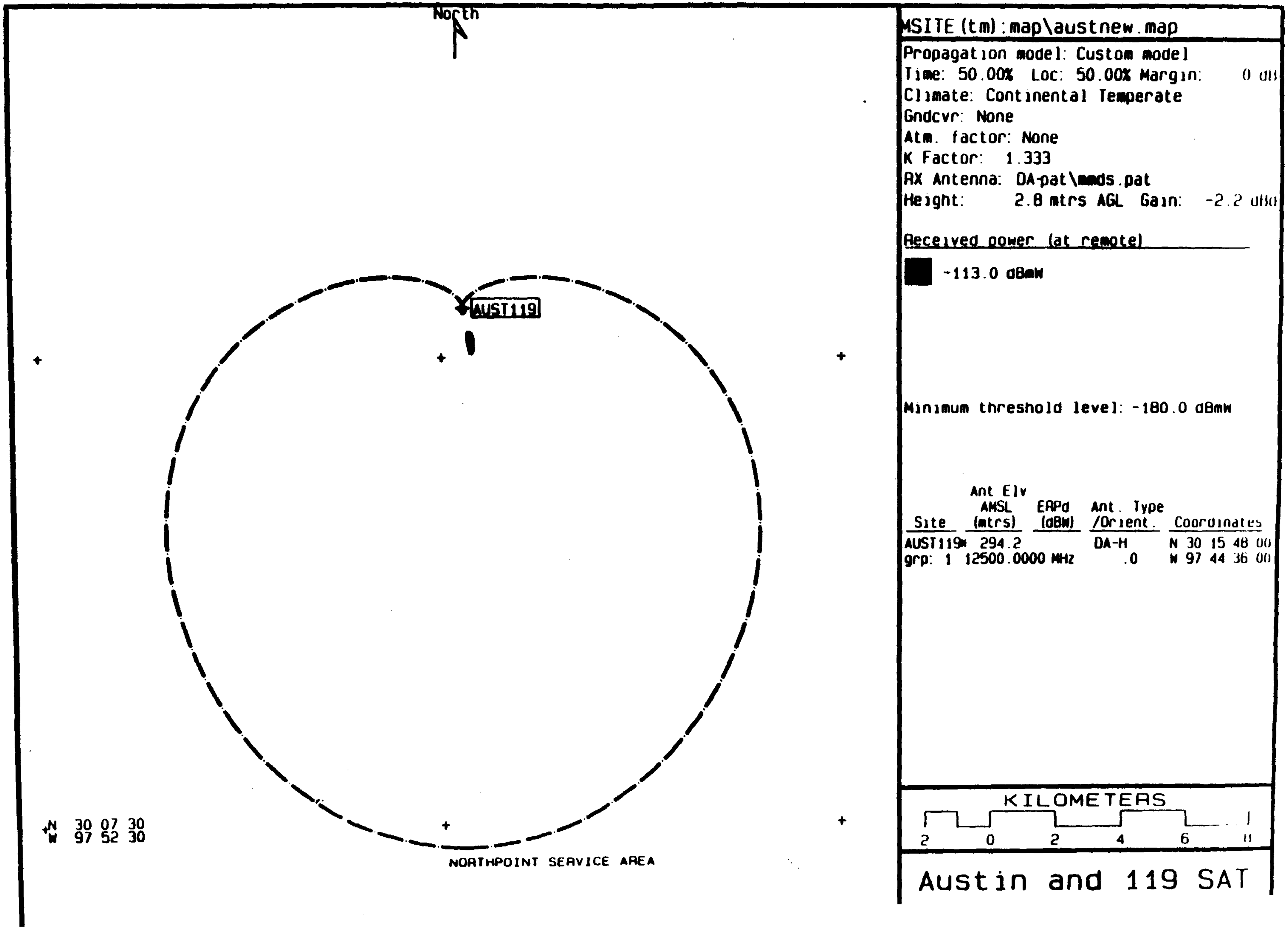
Minimum threshold level: -180.0 dBmW

Site	Ant Elv AMSL (mtrs)	ERPd (dBW)	Ant. Type /Orient.	Coordinates
AUST119*	294.2		DA-H	N 30 15 48 00
grp: 1	12500.0000 MHz		.0	W 97 44 36 00

KILOMETERS
2 0 2 4 6 8

Austin and 119 SAT

Exhibit 15


North
AUST119
N 30 07 30
W 97 52 30
NORTHPOINT SERVICE AREA
MSITE (tm) : map\austnew.map
Propagation model: Custom model
Time: 50.00% Loc: 50.00% Margin: 0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna: DA-pat\mmds.pat
Height: 2.8 mtrs AGL Gain: -2.2 dBd
Received power (at remote)
-113.0 dBmW
Minimum threshold level: -180.0 dBmW
Site
Ant Elv AMSL (mtrs)
ERPd (dBW)
Ant. Type /Orient.
Coordinates
AUST119* 294.2 DA-H N 30 15 48 00
grp: 1 12500.0000 MHz .0 W 97 44 36 00
KILOMETERS
2 0 2 4 6 8
Austin and 119 SAT

CERTIFICATE OF SERVICE

I hereby certify that on this 5th day of May, 1998, I caused copies of the foregoing Reply Comments of Northpoint Technology to be mailed via first-class postage prepaid mail to the following:

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